DOCUMENT RESUME

ED 196 903 SP 017 399

AUTHOR Webb, Norman L.; And Others
TITLE IGE Evaluation Phase IV: DMP Descriptive Study Final Report. Report from the Project on Evaluation of Practices in Individualized Schooling.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Individualized Schooling.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO WRDCIS-TR-558
PUB DATE Aug 80
GRANT OB-NIE-G-80-0117
NOTE 145p.; For related documents, see SP 017 400 and SP 017 405.

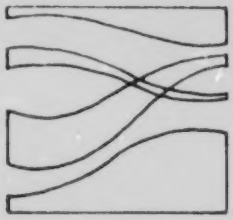
EDRS PRICE MF01/PC06 Plus Postage.
DESCRIPTORS Academic Achievement; *Cognitive Style; *Curriculum Evaluation; Elementary Education; Elementary School Mathematics; Grade 2; Grade 5; *Individualized Instruction; *Mathematics Instruction; Program Effectiveness; Program Evaluation; *Teaching Methods; *Time Factors (Learning)

ABSTRACT

Individually Guided Education (IGE) is a complex educational system intended to enable the elementary school to provide an environment where students learn at a rate and in a manner appropriate to their own learning styles. This descriptive study concerns the implementation of the Developing Mathematical Processes (DMP) instructional program, which was created to be compatible with the IGE system. DMP approaches mathematics through the measurement of attributes. The major content areas are problem solving, place value, attributes, measurement, addition and subtraction, multiplication and division, fractions, geometry, and statistics. An emphasis is placed on exploring relationships between objects using processes such as describing, classifying, ordering, equalizing, joining, separating, grouping, and partitioning. The study was carried out at two schools; grades 2 and 5 participated at each school, and data were collected through tests on general objectives of the program, observations, teacher logs, and interviews. Profiles by school for each grade on means of instruction (pacing, grouping, materials, and interactions), time use (allocated, nonapplied, available, and engaged time), and achievement provide a basis for discussing the relationships among the variables. The report concludes with an analysis of the relationships among the variables as well as a discussion of unanticipated outcomes having implications for educational research and elementary education as a whole. (Authors/CJ)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED196903



Technical Report No. 558

IGE Evaluation Phase IV: DMP Descriptive Study Final Report

by Norman L. Webb, Anne G. Nerenz, Thomas A. Romberg, and Deborah M. Stewart

U.S. DEPARTMENT OF HEALTH EDUCATION & WELFARE NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

August 1980

Wisconsin Research and Development
Center for Individualized Schooling

SP 017 399

Technical Report No. 558

IGE EVALUATION PHASE IV:
DMP DESCRIPTIVE STUDY FINAL REPORT

by
Norman L. Webb, Anne G. Nerenz,
Thomas A. Romberg and Deborah M. Stewart

Report from the Project on
Evaluation of Practices in Individualized Schooling

Thomas A. Romberg, Wayne Otto, and Norman L. Webb
Faculty Associates

Wisconsin Research and Development Center
for Individualized Schooling
University of Wisconsin
Madison, Wisconsin

August 1980

FEB 2 1981

MISSION STATEMENT

The mission of the Wisconsin Research and Development Center is to improve the quality of education by addressing the full range of issues and problems related to individualized schooling. Teaching, learning, and the problems of individualization are given concurrent attention in the Center's efforts to discover processes and develop strategies and materials for use in the schools. The Center pursues its mission by

- conducting and synthesizing research to clarify the processes of school-age children's learning and development
- conducting and synthesizing research to clarify effective approaches to teaching students basic skills and concepts
- developing and demonstrating improved instructional strategies, processes, and materials for students, teachers, and school administrators
- providing assistance to educators which helps transfer the outcomes of research and development to improved practice in local schools and teacher education institutions

The Wisconsin Research and Development Center is supported with funds from the National Institute of Education and the University of Wisconsin.

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR INDIVIDUALIZED SCHOOLING

Table of Contents

		Page
	List of Tables	vii
	List of Figures	xi
	Abstract	xiii
I	Introduction	1
	IGE and the Evaluation Project	1
	Overview of Phase IV	5
	Overview of Remaining Sections	8
II	Procedures	9
	The Developing Mathematical Processes Program	9
	Content Aggregations	10
	Data Collection	13
III	Description of the Schools	17
	Demographic Background	17
	IGE Background	18
	Implementation of DMP	22
	Initial Achievement	24
IV	Means of Instruction Profiles	27
	Grade 2	27
	School 433	27
	School 440	31
	Comparison of Grade 2 Classes in Schools 433 and 440	36
	Grade 5	37
	School 433	37
	School 440	41
	Comparisons of Grade 5 Classes in Schools 433 and 440	45
	Comparisons Within Schools Across Grade Levels	46
V	Time Profiles	49
	Grade 2	50
	Distribution of Instructional Days	50
	Allocated, Available, and Average Daily Time	50
	Time Profile for Content Covered	53

Page

Grade 5. 61
Distribution of Instructional Days. 61
Allocated, Available, and Average Daily Time. 63
Time Profiles by General Objective. 66

VI Achievement Profiles. 75

Grade 2. 76
Achievement Monitoring Tests. 76
Domain Referenced Tests 79
Target Students vs. Total Group 82
Contrast Between Schools on Achievement 82

Grade 5. 84
Achievement Monitoring Tests. 84
Domain Referenced Tests 87
Comparison of Target Students to Total Group. 89
Comparison Between Schools. 91

VII Interrelationships Among Variables. 95

Grade 2. 96
Grade 5. 111

References. 123

List of Tables

Table		Page
1	Mean Score and Percentile for Four Phase I Questionnaire Variables for School 433	19
2	Percent Correct on General Objectives for Test Time 1 From Achievement Monitoring Tests for Grade 2 and 5 at Schools 433 and 440	25
3	Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 433, Grade 2)	29
4	Means and Ranges in Percentages for Means of Instruction Variables for Each Observation Day (School 433, Grade 2)	30
5	Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 440, Grade 2)	33
6	Means and Ranges in Percentages for Means of Instruction Variables for Each Observation Day (School 433, Grade 2)	34
7	Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 433, Grade 5)	38
8	Means and Ranges in Percentages for Means of Instruction Variables for Each Observation Day (School 433, Grade 5)	40
9	Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 440, Grade 5)	43
10	Means and Ranges in Percentages for Means of Instruction Variables for Each Observation Day (School 440, Grade 5)	44
11	Average Distribution of Math Instructional Days For Periods A and B and Total Period (Schools 433 and 440, Grade 2)	51

Table		Page
12	Percent of Allocated and Available Times and Average Daily Time from Observations for Instructional Time Variables (School 433, Grade 2)	52
13	Percent of Allocated and Available Times and Average Daily Time from Observations for Instructional Time Variables (School 440, Grade 2)	54
14	Time Allocation from Logs and Time Observed on General Objectives by Period (School 433, Grade 2)	56
15	Time Allocation from Logs and Time Observed on General Objectives by Period (School 440, Grade 2)	59
16	Average Distribution of Math Instructional Days For Periods A and B and Total Period (Schools 433 and 440, Grade 5)	62
17	Percent of Allocated and Available Times and Average Daily Time From Observations for Instructional Time Variables (School 433, Grade 5)	64
18	Percent of Allocated and Available Times and Average Daily Time from Observations for Instructional Time Variables (School 440, Grade 5)	65
19	Time Allocation from Logs and Time Observed on General Objectives by Period (School 433, Grade 5)	67
20	Time Allocation from Logs and Time Observed on General Objectives by Period (School 440, Grade 5)	69
21	Objective Easiness and Gain Over Total Period on General Objectives from Achievement Monitoring Tests (Grade 2)	77
22	Mean, Standard Deviation, and Domain Difficulty on Three Basic Objectives from Domain Referenced Tests (Grade 2)	80

Table		Page
23	Comparison of Total Group and Target Students on Means for Three Basic Objectives from Domain Referenced Tests for Three Test Times by School (Grade 2)	83
24	Objective Easiness and Gain Over Total Period on General Objectives from Achievement Monitoring Tests for Three Test Times by School (Grade 5)	85
25	Mean, Standard Deviation, and Domain Difficulty on Three Basic Objectives from Domain Referenced Tests (Grade 5)	88
26	Comparison of Total Group and Target Students on Means for Three Basic Objectives from Domain Referenced Tests for Three Test Times by School (Grade 5)	90
27	Achievement and Instructional Time for School 433, Grade 2	97
28	Achievement and Instructional Time for School 440, Grade 2	104
29	Achievement and Instructional Time for School 433, Grade 5	112
30	Achievement and Instructional Time for School 440, Grade 5	118

List of Figures

Figure		Page
1	Phase IV model of anticipated relationships between variables.	6
2	Content aggregation levels for DMP for Grade 2	11
3	Content aggregation levels for DMP for Grade 5	12

Abstract

This report is part of Phase IV of the IGE Evaluation carried out by the Wisconsin Research and Development Center for Individualized Schooling. IGE (Individually Guided Education) is a complex educational system intended to enable the elementary school to provide an environment where students learn at a rate and in a manner appropriate to their own learning styles. Phase IV included five studies, three descriptive and two comparative. This descriptive study concerns the implementation of the Developing Mathematical Processes (DMP) instructional program, which was created at the R & D Center to be compatible with the IGE system. The study was carried out at two schools; grades 2 and 5 participated at each school, and data were collected through tests on general objectives of the program, observations, teacher logs, and interviews. Profiles by school for each grade on means of instruction (pacing, grouping, materials, and interactions), time use (allocated, nonapplied, available, and engaged time), and achievement provide a basis for discussing the relationships among variables. Analysis of the data resulted in anticipated and unanticipated findings which have implications for educational research and for elementary schooling as a whole.

I

INTRODUCTION

IGE and the Evaluation Project

Through the combined efforts of the Wisconsin Research and Development Center for Individualized Schooling, the University of Wisconsin IGE Teacher Education Project, the Kettering Foundation (I/D/E/A), and IGE coordinators in 25 states, more than 2,000 elementary schools have adopted a system called Individually Guided Education (IGE). This is a complex system based on theoretic and pragmatic ideas about schooling, children's learning, and the professional roles of school staffs. It was intended to influence elementary schooling in three general areas, organization, instruction, and intra- and inter-organizational relations, to provide:

> an environment in which the individual students learn at rates appropriate to each student and in a manner suitable to each student's learning style and other intellectual and personal characteristics (Klausmeier, Rossmiller, & Saily, 1977, p. 7)

More specifically, as an operating system IGE functions on the basis of seven components:

1. Multiunit organization

   Instruction and Research (I & R) unit at the instructional level
   Instructional Improvement Committee (IIC) consisting of the principal and unit leaders at the school level
   System-wide Program Committee (SPC) at the district level

2. Instructional programming for the individual student (IPM)

   Stating educational objectives
   Estimating the range of objectives attainable by subgroups of the student population

Assessing the level of achievement, learning style, and motivation
Setting instructional objectives for each child to attain over a short period of time
Planning and carrying out instruction for individual students
Assessing the attainment of objectives
Recycling through these procedures

3. Evaluation for educational decision making

Procedures to provide information about the student curriculum and overall school program at the beginning of a unit of instruction, during the instructional sequence, and at the end of a unit of instruction

4. IPM compatible curricular materials

Accurate and reliable content
Statements of instructional objectives
Suggested instructional activities appropriate to varied learning styles, reading levels, and other characteristics of individual students
Record keeping devices and procedures
Suitable in terms of cost

5. Home-school-community relations

6. Facilitative environments

Intraorganizational environment providing physical and material resources
Extraorganizational environment including state education agencies, intermediate educational agencies, and teacher education institutions

7. Continuing research and development

Thus, IGE has as its goals the instruction of students based on their individual level of achievement and learning styles, the development of particular types of organizational relationships within and outside of the school, and continuing research and evaluation.

Although much has been written about IGE as an alternative form of elementary schooling, no comprehensive picture exists showing the manner in which IGE has been implemented in these schools. Thus, in order to

gain a more detailed view of the day-to-day operation and effectiveness of the system as a whole, the IGE Evaluation Project was designed to identify features which contribute most to the success of reading skills and mathematics instruction as a result of individualized instruction (Romberg, 1976).

The evaluation project is comprised of five phases which were organized to provide complementary information on IGE. Phase I was a large sample study which provided basic information about IGE schooling. Certain features of IGE schooling have been reputed to be crucial to IGE success. The purpose of Phase I, then, was to examine the extent to which those presumably essential features had been implemented among IGE schools and to assess the effectiveness of that implementation. In this large sample study, including over 150 IGE schools, information was gathered from IGE school staff members using self-report surveys and from students using standard paper and pencil instruments. The data provided a functional understanding of IGE features, processes, and outcomes by relating a broad scope of variables in an interpretive manner.

Phase II verified and extended the self-report data gathered in Phase I to include more fully the range of variables that determine the process of schooling.

Phase III investigated the social meaning which emerges as IGE is used on a day-to-day basis. The problem of understanding the impact of educational reform can be approached by viewing schools as social institutions whose characteristics shape and are shaped by the behaviors of their members. This focus allows us to think of a school as a complex

social arrangement whose underlying patterns of conduct channel thought and action within that setting.

Since the success of IGE depends heavily on the availability of materials and evaluative procedures compatible with instructional programming for the individual student, an analysis of curriculum products designed to be used in IGE settings was undertaken. This aspect of the project--Phase IV--seeks to determine how well the three curricular programs developed for IGE meet their objectives, and to clarify the relationship of pupil outcomes to instructional time and means of instruction. In addition, Phase IV provides information about pupil activities and learning outcomes as they relate to specific objectives.

Finally, the goal of Phase V is to synthesize the results of Phases I through IV and to address the significant issues in contemporary schooling raised by the project as a whole. Each phase of the evaluation was designed to complement and strengthen the validity of the data gathered by the previous phases. For example, data on means of instruction, gathered by the large-sample study in Phase I, are examined in somewhat greater depth in fewer schools in the Phase II study. Phase III's analysis develops a view of instruction from a different perspective. Phase IV explores means of instruction within the specific curricular areas of reading and mathematics. Instead of merely adding together summaries of the different evaluation phases, Phase V is designed to integrate and interpret the data from all the phases into a series of statements of the project's implications for educational issues.

Overview of Phase IV

The intent of Phase IV was to describe in detail the actual operations in a sample of schools using curriculum materials designed to be compatible with IGE. Phase IV investigated three groups of variables--pupil outcomes, instructional time, and means of instruction--in IGE and non-IGE settings in which the Center's curriculum program as well as alternative curriculum materials were being used. Pupil attainment of program objectives is the dependent variable. The other two variables, instructional time and means of instruction, are essential in explaining and understanding how the programs work and how objectives are obtained. Instructional time was included because recent studies and reviews stress its importance and its relationship to pupil outcomes (Harnischfeger & Wiley, 1975; McDonald & Elias, 1976; Rosenshine, 1977). As Harnischfeger and Wiley state, "All influences on pupil achievement must be mediated through a pupil's active and passive pursuits" (p. 15). Instructional time and uses of instruction variables are also important from a practical point of view because they can be manipulated by teachers: Describing the use of each program in terms of allocated time, engaged time, and instructional activities provides concrete factors that teachers can manipulate in preparing and conducting instructional activities. The structural relationships among these variables are illustrated in Figure 1.

In sum, the primary purposes of Phase IV are:

1. to determine the degree to which the Wisconsin Design for Reading Skill Development (WDRSD) (Otto, 1977), the Pre-Reading Skills program (PRS) (Venezky & Pittelman, 1977), and Developing Mathematical Processes (DMP) (Romberg, 1977) meet their objectives and skills.

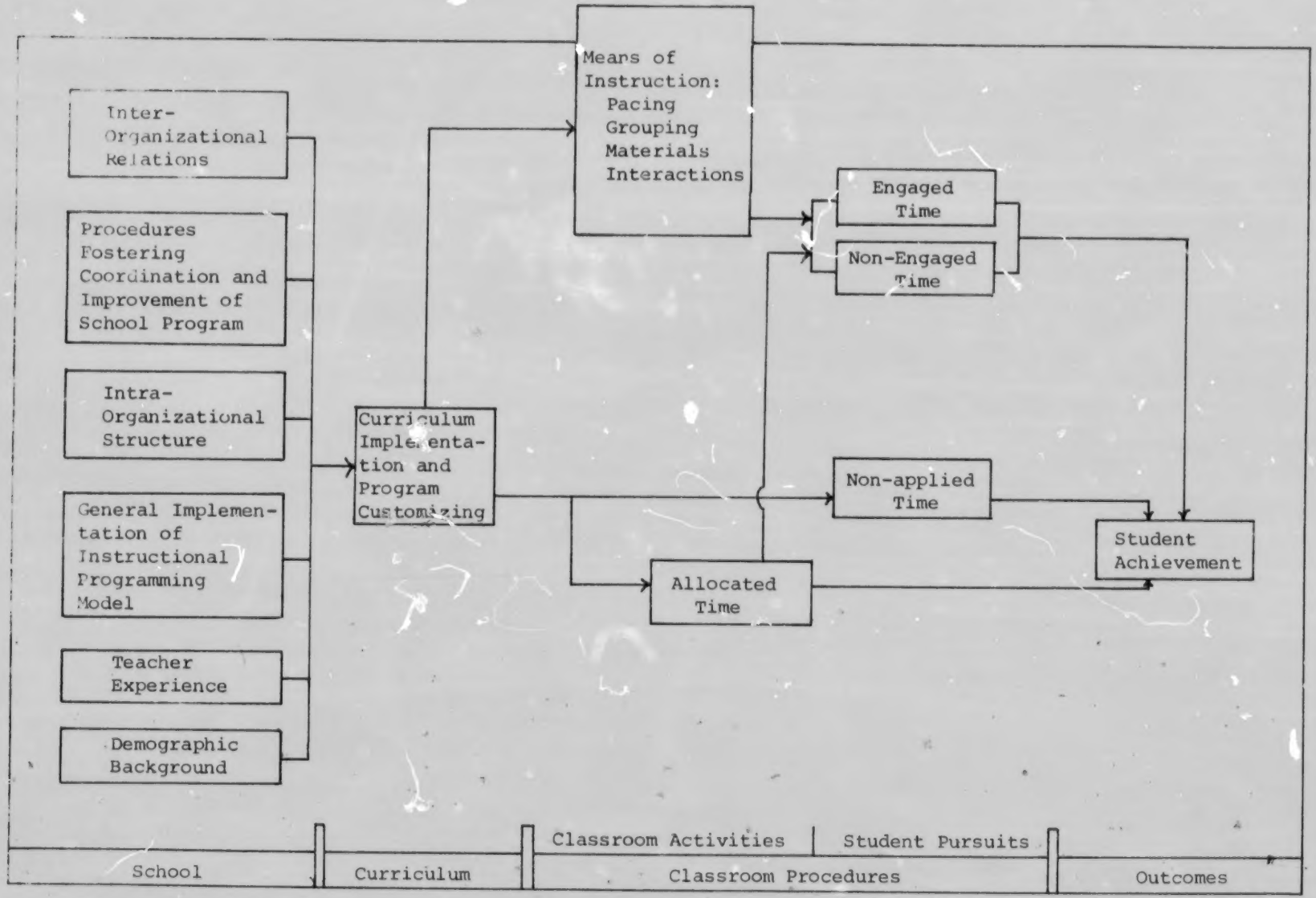


Figure 1. Phase IV model of anticipated relationships between variables.

2. to determine how time is allocated for instruction in implementing WDRSD, DMP, and PRS.

3. to relate instructional time to the means of instruction and mastery of content for WDRSD, DMP, and PRS.

4. for each curriculum program, WDRSD and DMP, to contrast two situations--IGE schools using the program with non-IGE schools using the program and IGE schools using the program with IGE schools using alternative programs--on the variables of pupil outcomes, instructional time, and means of instruction.

Five studies were conducted as part of Phase IV, three descriptive studies and two comparative studies. The descriptive studies were small sample studies designed to describe how each of the three curriculum programs were being used in IGE schools. The studies were conducted from January to May 1978 at two IGE schools using DMP, two IGE schools using WDRSD, and three IGE schools using PRS. A more detailed description of the two DMP schools is provided in section III of this paper. Achievement monitoring and domain referenced tests, observations, teacher logs, and interviews were used to collect the data. These procedures were piloted for subsequent use in the comparative study. A more detailed description of the design for the descriptive studies is given in Project Paper 79-42 (Webb & Romberg, 1979).

Data were gathered for the two comparative studies from October until May during the 1978-1979 school year. Three types of schools were included in these studies: (a) IGE schools using DMP or WDRSD; (b) Non-IGE schools using DMP or WDRSD; and (c) IGE schools using alternative programs. Four triads of schools were selected for WDRSD and three triads for DMP, with each triad containing one school of each of the three types just mentioned. Only students in grades 2 and 5 and their teachers participated in the study. As in the descriptive

studies, data were collected by four means: tests on general objectives of each program, observations, teacher logs, and interviews.

Overview of Remaining Sections

This report deals with the DMP descriptive study. Following an outline of the DMP curriculum program and a summary of the data collection procedures, a description of the two schools which participated in the study is provided. Grade 2 and grade 5 profiles by school for the means of instruction (pacing, grouping, materials, interactions), time (allocated, nonapplied, available, engaged), and achievement variables are considered in subsequent sections. The report concludes with an analysis of the relationships among the variables as well as a discussion of unanticipated outcomes having implications for educational research and, more generally, elementary schooling as a whole.

II

PROCEDURES

This section provides an overview of the procedures used in the descriptive study. The description of DMP provides an overview of the important features of the curriculum program which distinguish it from other mathematics instructional programs. Because data on the content of instruction were obtained from several sources on basic objectives and then combined for analysis, a list of the mathematics objectives at each level of aggregation is included, followed by a description of the data collection procedures themselves.

The Developing Mathematical Processes Program

DMP (Romberg, Harvey, Moser, & Montgomery, 1974, 1975, 1976) is a total program of elementary mathematics for grades K-6. It is composed of 90 topics which correspond approximately to grade levels as follows:

Topics	1-14	Grade K
	15-27	Grade 1
	28-40	Grade 2
	41-53	Grade 3
	54-65	Grade 4
	66-77	Grade 5
	78-90	Grade 6

The components of DMP are resource manuals, teacher's guides for each topic, student booklets and guides, printed and physical materials kits, a preassessment package, topic inventories, and pupil performance records.

DMP approaches mathematics through the measurement of attributes. The major content areas are problem solving, place value, attributes, measurement, addition and subtraction, multiplication and division, fractions, geometry, and statistics. An emphasis is placed on exploring

relationships between objects using processes such as describing, classifying, ordering, equalizing, joining, separating, grouping, and partitioning.

For each topic a sequence of activities is specified. Alternate activities are included for students who need more work on an objective or a variation in instruction. The activities are keyed to objectives. The topic inventories are used to assess mastery of the objectives for each topic. Instructional activities include experiments, use of manipulatives, learning stations, games, stories, discussions, worksheets, and contests.

Content Aggregations

In the descriptive study of Phase IV, information on the content taught during instruction using DMP was obtained from the teacher logs, classroom observations, and achievement monitoring tests. These data were grouped for analysis at four progressively more specific levels. The most inclusive is the "content area," followed by the "general objective," the "specific objective," and the "basic objective."

The aggregation levels of objectives are shown in Figure 2 for grade 2 and in Figure 3 for grade 5. The nine content areas, which are the same for grade 2 and grade 5, correspond generally to the content strands used to organize DMP topics. The content area "decimals" was used as a separate aggregation level to distinguish outcomes in this area from outcomes in the area of fractions in the form of a/b. A miscellaneous content area was included since some teachers used material from other sources whose content could not be classified as any

Content		General Objective		Specific Objective		Descriptor	
Case Number	Descriptor	Case Number	Descriptor	Case Number	Descriptor	Case Number	Descriptor
01	Addition and subtraction	01	Writes sentences	01	Equalization	03	Writes equalization sentence 0-20-Type A
						04	Writes equalization sentence 0-20-Type B
				02	Joining and Separating	05	Writes joining or separating sentence 0-20
						07	Writes difference sentence 0-20
						13	Writes sentence 0-99
						30	Writes part-whole sentence 0-20
		02	Computes	03	Sentences	08	Solves open sentence 0-10
						10	Solves open sentence 0-20
						17	Solves open sentence 0-99
				04	Vertical Form Addition	15	Computes sum 0-99
						21	Computes--addition
				05	Vertical Form Subtraction	16	Computes difference 0-99
						22	Computes--subtraction
02	Numeration	03	Counting	06	Grouping	06	Writes grouping notation
				07	Compact	18	Writes compact 0-999
				08	Place Value	24	Place Value
				09	Writes Numbers	02	Writes numbers 11-20
						09	Writes numbers 0-99
		04	Inequalities	10	Writes order sentence	01	Writes order sentence
				11	General	20	Inequalities
03	Fractions	05	Fractions	12	Concept	11	States whether fractional part
						26	Fractions miscellaneous
				13	Representation	12	Represents fractional name
04	Decimals	06	Decimals	14	Decimals	99	Decimals
05	Multiplication and Division	07	Computes	15	Multiplication	23	Computes--multiplication
06	Measurement/ Attributes	08	Measurement/ Attributes	16	Length	14	Assigns standard length measurement
				17	Miscellaneous	27	Measurement
				18	Attributes	31	Sorts on 2 attributes
07	Geometry	09	Geometry	19	Geometry	28	Geometry
08	Problem Solving	10	Problem Solving	20	Applications	19	Applications problems
				21	Word Problems	25	Word Problems
09	Miscellaneous	11	Miscellaneous	22	Miscellaneous	29	Other

Figure 2. Content aggregation levels for DMP for grade 2.

Content		General Objective		Specific Objective		Descriptor	
Case Number	Descriptor	Case Number	Descriptor	Case Number	Descriptor	Case Number	Descriptor
01	Addition and Subtraction	01	Computes	01	Writes sentences	66	Writes + or - sentence
				02	Solves sentences	67	Solves + or - sentence
				03	Vertical addition	69	Computes--addition
				04	Vertical subtraction	70	Computes--subtraction
02	Numeration	02	Numeration	05	Notation	65	Numeration/place value
				06	Number theory	73	Number Theory
03	Fractions	03	Concept	07	Concept	72	Fractions-concept
				08	Common fraction equivalence	52	Finds equivalent common fraction using representation
				09	Mixed number equivalence	54	Finds equivalent common fraction or mixed number
				10	Decimal equivalence	83	States equivalent decimal for common fraction
				11	Ordering	55	Orders common fraction less than 1
		04	Computes	12	Writes sentences	56	Writes + or - sentence with common fractions less than 1
				13	Adding and Subtracting	57	Solves + or - sentence with common fractions less than 1
						77	Writes and solves + or - common fraction sentence less than 1
				14	Grouping and partitioning	78	Solves grouping or partitioning common fraction problem
				15	a x b = □ (a & b fractions)	79	Solves a x b = □ (involving fractions)
04	Decimals	05	Concept	16	Ordering	59	Orders decimals
				17	Decimal measure	58	Assigns decimal measurement
		06	Computes	18	Addition	61	Computes decimal sum
				19	Subtraction	62	Computes decimal difference
				20	Addition/Subtraction	80	Computes decimal sum or difference (problems mixed on page)
				21	Multiplication	81	Finds product of decimal and whole number
				22	Division	82	Divides decimal by whole number
05	Multiplication and Division	07	Computes	23	Writes sentence	51	Writes x or ÷ sentence
				24	Multiplication	53	Finds product 0-9,999 (Same as Topic 75, Objective 3)
						63	Finds product 0-999,999
				25	Division	60	Divides by 1-digit numbers using algorithm (Same as Topic 72 Objective 1)
				26	Solves sentences	84	Divides by 2-digit number
						68	Solves x or ÷ sentence
06	Measurement/ Attributes	08	Measurement/ Attributes	27	Measurement/Attributes	99	Measurement/Attributes
07	Geometry	09	Geometry	28	Geometry	74	Geometry
08	Problem Solving	10	Problem Solving	29	Application	64	Application problems
				30	Word problems	75	Word problems
09	Miscellaneous	11	Miscellaneous	31	Computes	71	Other computation
				32	Other	76	Other

Figure 3. Content aggregation levels for DMP for grade 5.

of the other content areas. A more detailed explanation of the objectives which were included in each aggregation is provided in Project Paper 80-1 (Nerenz & Webb, 1980).

Data Collection

Tests. Two types of tests were used to measure pupil outcomes for the descriptive study. Information on achievement was obtained at three points in time using achievement monitoring procedures. This procedure provides a means of assessing achievement on a large number of objectives at several points in time, and yields more information on the growth of groups of students than would be obtained by a simple pretest-posttest design.

A total of 19 objectives for grade 2 and 15 objectives for grade 5 were identified as representing the range of objectives normally covered during instruction at those grade levels. Four items for each objective were written to correspond to the items included in the topic inventories for each objective. The items were then arranged on four test forms with each form containing one item for each objective tested. During each testing, a fourth of the pupils were given each form. The forms were systematically rotated among the groups of students for each test time. The score, or percent correct, for each objective was computed using the corresponding items from all forms. Data were obtained from this procedure for the group of students.

The second testing procedure, domain referenced testing, was used to obtain information on all students for three math objectives for each grade level. Using an operational definition of the math objective

specifying exactly what content composed the domain, items were selected or created, and assigned to a test form. The same form was administered to all pupils with 10 items used to test each objective. Details on both testing procedures are provided in Project Paper 79-28 (Webb, 1979c).

Observations. The Phase IV observation system, modeled after the one used in the Beginning Teacher Evaluation Study (Mariave, Fisher, Filby, & Dishaw, 1977), was designed to describe how DMP was being used in a small sample of IGE schools. In particular, the observation system used time as a metric to describe how the curriculum program helps students achieve the objectives of the program. The categories used in the observation system were:

Nonapplied time - - -	time devoted to other than the curricular program being observed
Specific content- - -	math objective or reading skill
Pace- - - - - - - - -	whether or not the student is working at his or her own pace
Grouping- - - - - - -	size of group of which the student is a member
Materials - - - - - -	the materials being used by the student
Learner moves - - - -	student engagement or nonengagement
Interaction - - - - -	persons with whom the student is interacting and the direction and focus of that interaction

This procedure involves observing a single "moment" within a longer period of time and recording the "event" that took place during the instant. Briefly, a sample of six randomly selected target students were observed in a cycle of approximately 3 1/2 minutes. For the first target student, the observer took a "snap shot" of what the target student was doing at the beginning of the cycle. Then the student

activity during the instant observed was recorded on the form by filling in the appropriate categories, after which the next target student was observed for a moment and his or her activity coded. The procedure continued until all six target students had been observed, taking approximately 3 minutes. Thirty seconds were then taken to record the major role of the teacher(s) and general activities occurring in the classroom. This cycle was repeated, observing each target student in sequence and recording general comments, during the time allocated for work on the curriculum program. A more detailed description of the observation procedures is provided in Project Paper 79-32 (Webb, 1979k).

Logs. In the descriptive study, logs were maintained for a sample of six target students at each grade level to obtain a measure of the total time allocated to instruction on specific objectives during the investigative period. These were completed by the teachers who were directly responsible for instruction. On the logs, the amount of time allocated to instruction on each mathematics objective, the size of the group with which the target student was working, and the type of materials being used were recorded. A more detailed description of the logs and logging procedures is provided in Project Paper 79-31 (Webb, 1979l).

Interviews. Interviews were conducted at school 433 with at least one teacher at grades 2 and 5 to obtain information on a small number of background, organizational, curriculum, and instructional variables. Transcripts and summaries of these data are available in Project Paper 79-30 (Nerenz, 1979).

III

DESCRIPTION OF THE SCHOOLS

The descriptive study of Phase IV was designed to provide detailed information about instruction in mathematics at grades 2 and 5 for two schools. Both schools had used DMP at the lower grades since the initial school trials of the materials. As the materials became available for subsequent grades, DMP was eventually used at grades K through 5. These schools were selected to participate in the descriptive study because of their use of DMP, their identification as IGE schools, and their differences in demographic setting. In this section of the report, the demographic, IGE backgrounds, program implementation, and initial achievement variables are compared for the two schools.

Demographic background

School 433 is 1 of 12 elementary schools in a middle to upper-middle class city of 55,000, which served the children of professional and university people, factory workers and small businessmen, as well as children from the more rural, neighboring townships. Six of these schools were IGE in structure and three used the DMP curriculum program. School 433 is located in a neighborhood adjacent to the university and the observer noted there were "many associations with the university." The 390 students were served by 15 teachers, with the average class size between 20 and 25. Special services included a Department for the Hearing Impaired involving 55 of the children.

School 440 is located in a town of about 2,000 people and serves children from the town and its surrounding rural area. It is one of

three elementary schools in the district and had been a trial school using DMP since its developmental stages. The program was implemented in sequence with the students who began with DMP in kindergarten continuing with the program during each successive year. There are approximately 350 students served by 13 teachers.

IGE Background

School 433 was organized initially into units in the fall of 1971. Meetings were held four times a year for a group of representatives from the IGE schools in the district. School 433 also belonged to a regional network of IGE schools which included schools from outside of the district.

The school was organized into three units. The primary units, K-2 and 3-4, used cross-grading. The upper unit, 5-6, functioned more as departments with children grouped according to their grade level. The children moved from math to science to social studies to language arts using 40 or 50 minute periods. The unit leader had the responsibility for math instruction for all of the students.

The Instructional Improvement Committee (IIC) was composed of the unit leaders and principal and met regularly once a week. Paid and volunteer instructional or clerical aides were used. In addition to the DMP curriculum program, the school used PRS and WDRSD. Since school 433 had also participated in Phase I, information is available from the Phase I self-report questionnaires on variables describing the general characteristics and organization of the school. The values on four of the variables for school 433 are given in Table 1 along with the mean

Table 1

Mean Score and Percentile for Four Phase I Questionnaire Variables for School 433

Variable	156 Phase I Schools	School 433	
	Mean	Score	Percentile
IOR	17.2	17.7	56
IOS	20.5	22.5	64
GOS	56.9	57.7	53
IPM	62.4	53.4	24

values for the 156 Phase I schools. The scores on the variables representing the organization and instructional procedures used at school 433, as developed from responses to the Phase I questionnaires, generally were close to the mean of the Phase I sample of schools. These variables are defined below.

The first variable, Interorganizational Relations (IOR) measures the school's interrelationships and activities with persons and organizations outside of the school, especially those believed to facilitate implementing and maintaining IGE. It deals with the role and frequency of meetings of the Systemwide Program Committee (SPC), school involvement in a network of IGE schools, and community relations.

Interorganizational Structure (IOS) is a measure of certain aspects of the school's internal organization which are relevant to implementing IGE. Organizational structures within the school (Instructional Improvement Committee, Instruction & Research units, etc.) are assessed for characteristics such as membership composition, frequency of meetings, permanence of leadership, amount of release time made available for meetings, whether parents and others participate in the activities of such groups, whether agenda of meetings are kept, and how agenda are distributed. The existence and responsibilities of certain supplementary staff positions (IMC directors, student teachers, aides, and interns) are also assessed as part of the internal organization of the school.

The third variable, Procedures Fostering Coordination and Improvement of the School Program (GOS), is a measure of procedures in the school that are supposed to foster continuing improvement of the overall school program. Included are research and development, staff

development, use of volunteers and aides, noninstructional (advisory) contact between teachers and students, and other aspects of home-school-community relations.

General Implementation of the Instructional Programming Model is a measure of implementation of general school practices that have been encouraged by the Wisconsin R&D Center as supportive of the Instructional Programming Model (IPM). It is based on self-reported practices of: (a) setting school-wide instructional objectives by the Instructional Improvement Committee (IIC); (b) adapting school-wide objectives in Instruction & Research (I&R) units; (c) using IIC guidance in the development of record-keeping procedures; and (d) providing for carrying out the IPM in the I&R units of the school.

School 440 was organized initially in units in fall of 1970. There were other IGE schools in the school district, but regular meetings regarding IGE did not occur with representatives from these schools. School 440 did belong to a group of IGE schools which included schools from outside of the district.

School 440 was organized into three units: kindergarten, grades 1-3, and grades 4-6. In the two units with older students, all of the skill areas were reported as being IGE subjects and the IPM was used. Approximately 5 hours per week of release time was provided for the staff in each unit. The principal and unit leaders met once a week. Both paid and volunteer instructional or clerical aides were available. Besides DMP, the WDRSD was used.

Implementation of DMP

DMP was used at school 433 for 5 years at the primary level with teachers in the K-2 unit having used it for 3 of those years. The major responsibility for instruction was given to the teacher. From the interviews of teachers it was noted that "occasionally a volunteer mother or the teacher's aide will take a small group to help with story problems," but that few other people helped with teaching DMP. Some form of inservice program was held annually for the teachers.

Instructional groups were based on student ability and determined through the grade level topic inventory. Such groups were relatively stable throughout the year:

> Each year a teacher will have a different level group but during the year they normally do not change. Individuals may change groups once in a great while. . . . [Tests were administered] at the end of each topic. [However, regroupings were not based on these evaluations and] the individual teacher has much discretion . . . as to what they should do next. (Excerpts from an interview of a grade 2 teacher at school 433, Nerenz, 1980, p. 103.)

All of the DMP materials except the Student Guide were used in the K-2 unit. In addition, at grade 2, the program was supplemented by other worksheets, memorization facts, flash cards, and games from other curriculum programs, although math concepts and skills were only dealt with during the scheduled math period. The DMP Cumulative Record Form on topic objectives was the only record-keeping system.

During math instruction students were divided into separate classrooms making it difficult to observe students in more than one classroom. Observations were made and logs were maintained for students in the unit's middle ability group, approximately 30 students.

In grade 5 at school 433, as in grade 2, DMP had been implemented since its initial development. The grade 5 materials, at the time of the study, had only been available in published form for approximately 1 year. The initial inservice of the material in its developmental stage was in the form of "a discussion of [the] manual 3 years ago with someone from Madison." In the unit containing fifth graders, students were grouped by homeroom and generally remained in these groups for the school year. Students were not grouped by ability. Tests were administered at the end of each topic and instruction on different topics was sequenced according to the flow chart in the manual. Topics within the same strand were taught in sequence rather than presenting topics numerically.

Several of the DMP materials were used: "The manual, guides, and workbooks are used extensively but the manipulatives are not used much and the games are almost never used. . . . the games didn't allow enough students to play at one time" (Nerenz, 1980, p. 107). The program was supplemented by "a library of other commercial games that are math related" and handouts from 28 other texts "to provide for more or different practice in various areas" (Nerenz, 1980, p. 107). In addition, graphs, averages, and other math concepts were included during social studies and science instruction. The cumulative record and a grade book for supplemental assignments composed the record-keeping system.

Students at school 440 were grouped by grade level. Within grade levels two ability groups for math instruction were formed that remained relatively stable throughout the year. With the exception of occasional student teachers, no one other than the teacher was involved in implementing

DMP. DMP topics were generally covered in numerical sequence without deleting any. While both grade 2 teachers and one grade 5 teacher used primarily DMP materials, including student guides, workbooks, manipulatives, and the resource manual, the other grade 5 teacher supplemented the program with a large number of worksheets.

Initial Achievement

Scores from the first administration of the achievement monitoring tests were aggregated into seven general objectives at grade 2 and six at grade 5 and are reported for both schools by grade in Table 2. The scores indicate that differences between the two schools in the level of achievement on some objectives were apparent at the beginning of study. Grade 2 students from school 433 had noticeably higher scores on the objectives of writing sentences and addition/subtraction computation. Students from school 440 scored higher on fractions. On the other four grade 2 objectives, the percent correct scores were close, with school 433 students generally scoring higher.

For grade 5 the trend is switched with scores from school 440 generally being higher. Noticeable differences of 15 percentage points or higher occurred for fractions-concept, fractions-computations, decimals-concept, and multiplication/division computations. The scores from school 440 were all higher except for multiplication/division computations. On the other two objectives scores were close; however, the percent correct were still higher for school 440 than for school 433.

Thus, the two schools that participated in the DMP descriptive study were different in certain aspects. The two schools were located

Table 2

Percent Correct On General Objectives For
Test Time 1 From Achievement Monitoring Tests
For Grade 2 and 5 at Schools 433 and 440

General objective	School 433	School 440
Grade 2	(N=30)	(N=55)
1. Writes sentence (+/-)	.61	.33
2. Addition/subtraction computation	.45	.24
3. Counting	.68	.60
4. Inequalities	.80	.73
5. Fractions	.32	.46
8. Measurement/attributes	.33	.25
10. Problem solving	.38	.39
Grade 5	(N=41)	(N=46)
3. Fractions-concept	.37	.54
4. Fractions-computation	.28	.48
5. Decimals-concept	.48	.63
6. Decimals-computation	.16	.25
7. Multiplication/division computation	.67	.49
10. Problem solving	.17	.20

in communities of different demographic characteristics and different sizes. Teachers at school 440 taught the topics in numerical sequence whereas teachers at school 433 selected certain topics for instruction and ignored others. The level of achievement at the beginning of study varied on several of the general objectives at both grades. The schools had similar procedures in grouping students; students at a grade level were grouped into two or three ability levels at the beginning of the year. Students generally remained in these groups for the school year. At grade 5 in school 433, one teacher was responsible for the primary instruction of the entire group.

IV

MEANS OF INSTRUCTION PROFILES

Information on procedures and materials used during DMP class periods was obtained from time-sampling observations of six randomly selected children. Four means of instruction variables were considered--pacing, grouping, materials, and interactions. Detailed descriptive information on these variables by school and grade is reported in Project Papers 79-18, 79-15, and 80-1 (Webb, 1979a, 1979j, Nerenz & Webb, 1980, respectively). A summary of that information is reported in this section. We describe the means of instruction by grade for each school, the differences among individual students, the differences between the two schools by grade level, and the commonalities of the means of instruction within a school

Grade 2

School 433

Twelve observations were made of a grade 2 DMP class at school 433 over a 17-week period. The class contained approximately 30 students with 1 teacher and the length of each class period was 35 minutes. The students were in the middle ability range in mathematics. Other math classes, conducted at the same time, had students in the higher and lower ability groups. One of the six target students being observed was transfered to a higher group during period A. Another student was selected as a replacement. Thus, on occasion, students did move between groups.

Pacing and grouping. For nearly 50% of the allocated time students were in large group settings and paced by the teacher (Table 3). Self-paced and individual work occurred on an average of 22 to 33% of the time with some variation occurring between the two periods. Small groups were observed very infrequently and only on day 10 (Table 4) were more than one or two of the target students engaged in small group activity for any significant amount of time.

As indicated by the total percent of allocated and available times in Table 3, the pattern was to use other-paced activities more than individual self-paced work. However, there was a large variation in pacing and grouping on a day-to-day basis as shown in Table 4. On days 2, 4, 10, and 12, self-paced individual activities were primarily used. On days 1, 5, 9, and 11, almost the entire time was spent in other-paced large group activities. Little variation occurred for individual students in pacing and grouping by day as seen by the low ranges of percentages, usually less than 25%. Only on days 3 and 10 did the time spent by individual students differ noticeably in pacing and grouping.

Materials. The materials used most often were paper and pencil (workbooks and worksheets) and manipulatives (chips, links, unifix cubes, and geo pieces). Games of bingo and round-the-world were played on one occasion each. Paper and pencil materials were used every day (Table 4) with very little variation among individual students. Manipulatives were used on 9 of the 12 observation days and, on 5 of these days, were used with different frequencies by different students. Sometimes chips were used as an aid in counting by some students, but were not needed by others. This is one way that the materials were used to meet individual differences.

Table 3

Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 433, Grade 2)

Variable	Period A (7 days)			Period B (5 days)			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
Pairing									
Self	33	42	11	4	28	8	29	36	10
Other	47	58	16	7	72	20	51	64	17
Grouping									
Individual	33	42	11	19	24	7	27	34	9
Small	1	1	0+[a]	5	7	2	3	4	1
Large	46	57	16	55	69	19	50	62	17
Materials									
Paper and pencil	68	85	23	51	76	21	65	81	22
Printed	0	0	0	0	0	0	0	0	0
Manipulative	26	33	9	32	40	11	29	36	10
Game	5	7	2	5	6	2	5	7	2
Other	2	2	0	0	0	0	1	1	0+
Interactions									
Target ↔ Teacher	2	2	0+	1	2	0+	1	2	1
Teacher ↔ Target	0+	0+	0+	0+	0+	0+	0+	0+	0+
Target ↔ Student	2	2	1	4	6	2	3	4	1
Target or Student ↔ Group	1	1	0+	4	5	1	2	3	1
Teacher ↔ Group	10	12	3	13	17	5	11	14	4

Note. Average time per class day is 35 minutes.

[a] 0+ designates a positive value less than .5.

Table 4

Means and Ranges in Percentages for Means of Instruction Variables for each Observation Day (School 433, Grade 2)

Variable	Observation day: Period A 1	2	3	4	5	6	Period B 7	8	9	10	11	12	Mean over days
Pacing													
Self													
Mean[a]	4	78	42	53	0	26	44	22	0	45	0	55	31
Range[a]	7	8	34	24	0	10	11	9	0	20	0	10	11
Other													
Mean	72	8	52	33	84	61	44	51	88	38	90	21	54
Range	7	19	34	24	21	20	20	19	11	50	0	0	19
Grouping													
Individual													
Mean	4	78	42	51	0	26	44	22	0	30	0	51	29
Range	7	9	34	23	0	10	11	9	0	20	0	20	12
Small													
Mean	0	2	0	8	0	0	0	0	0	23	0	4	3
Range	0	10	0	23	0	0	0	0	0	20	0	10	5
Large													
Mean	72	7	52	27	84	61	44	51	88	30	90	21	52
Range	7	10	34	0	21	20	20	19	11	50	0	0	16
Materials													
Paper and pencil													
Mean	18	85	94	84	84	64	67	22	69	83	67	75	68
Range	7	11	11	9	0	10	10	9	0	50	11	10	12
Manipulatives													
Mean	57	40	0	18	57	28	6	10	65	83	0	0	30
Range	7	79	0	41	11	49	19	42	11	50	0	0	26
Game													
Mean	57	0	0	0	0	0	0	25	0	0	0	0	7
Range	7	0	0	0	0	0	0	9	0	0	0	0	1
Printed material													
Mean	0	0	0	0	0	0	0	0	0	0	0	0	0
Range	0	0	0	0	0	0	0	0	0	0	0	0	0

Note. Within each day, for each variable the upper number is the mean for all students observed and the lower number is the range across students.

[a]Means and ranges are percentages.

Interactions. Corresponding to the extensive use of large group activities, the predominant interactions were from the teacher to large group (giving directions and explanations and asking questions). These interactions, however, occurred less than 15% of the allocated time or, on the average, for 5 minutes per day. A few one-to-one interactions occurred with a target student talking to the teacher or two students talking with each other. An increase in interactions was recorded in period B for a student talking to another student or to the group. This increase may be the result of the improved skill of the observer in recording interactions after the retraining session between the two periods and should be interpreted with caution. Even taking this into consideration, interactions occurred for less than 25% of the allocated time for either period.

Summary. Overall at school 433, grade 2 math instruction occurred both in large group other-paced and individual self-paced activities with slightly more time spent in large group settings. The pacing and grouping varied on a day-to-day basis. Paper and pencil materials were used primarily, with extensive use of manipulatives. Manipulatives were used in different frequencies by different students. Drill and practice games were used only on a few occasions. Interactions occurred less than one-fourth of the time and were generally the teacher talking to the group.

School 440

The two classes of grade 2 students at school 440 were observed 16 times, 8 in period A and 8 in period B. Each class had approximately

28 students and 1 teacher. Three target students were selected from each group and were observed in sequence: three from one class followed by three from the second class. This was possible since the space where the two classes were held was an open area partitioned by room dividers and shelves allowing the observer easy passage between the two classes. The average length of the class period was 38 minutes.

Pacing and grouping. The time spent in large group activities paced by the teacher (Table 5) remained constant over the two periods at little over one-third of the allocated time. Nearly 50% of the allocated time in period A students paced themselves, working individually or in small groups. The time spent in small groups, 19% of the allocated time, is large compared to other classes observed. However, in period B a smaller proportion of the allocated time was spent in small groups. The percentage of nonapplied time also increased in period B which indicates a variation in the profiles of instruction between the two periods. Overall the time was fairly evenly divided between self-paced and other-paced activities using all three groupings.

On a day-to-day basis (Table 6), self-pacing varied slightly, from a mean percentage across students of 30 to 56%, except on 2 of the 16 days. The daily ranges of percentages across students were high with over half of them larger than 50%. One reason for the large values is that one teacher used more other-paced large group instruction while the other used more self-paced small and individual activities. Thus, the large ranges were due more to teacher instructional style than attending to individual differences of students. Within each group the ranges among students were small. The same teacher effect applies

Table 5

Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 440, Grade 2)

Variable	Period A (8 days)			Period B (8 days)			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
				Pacing					
Self	45	55	17	36	49	14	40	52	16
Other	37	45	14	38	51	14	38	48	14
				Grouping					
Individual	27	33	10	31	42	12	29	37	11
Small	19	23	7	5	7	2	12	16	5
Large	36	44	14	38	51	14	37	47	14
				Materials					
Paper and pencil	58	72	22	58	78	22	58	75	22
Printed	7	8	3	0+[a]	0+	0+	3	4	1
Manipulative	37	45	14	10	13	4	23	30	9
Game	0	0	0	4	6	2	2	3	1
Other	0	0	0	0	0	0	0	0	0
				Interactions					
Target → Teacher	3	3	1	1	1	0+	2	2	1
Teacher → Target	1	1	0+	0+	0+	0+	0+	1	0+
Target ↔ Student	4	5	2	3	4	1	4	5	1
Target or Student → Group	1	1	0+	1	1	0+	1	1	0+
Teacher → Group	14	18	5	14	18	5	14	18	5

Note. Average time per class day is 38 minutes.

[a] 0+ designates a positive value less than .5.

Table 6

Means and Ranges in Percentages for Means of Instruction Variables for each Observation Day
(School 433, Grade 2)

Variable	Observation day																Mean over days
	Period A								Period B								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Pacing																	
Self																	
Mean[a]	30	39	41	52	46	53	54	71	56	51	32	38	31	4	51	44	43
Range[a]	40	43	73	50	50	55	50	18	22	59	54	63	64	18	17	46	45
Other																	
Mean	58	44	49	36	44	32	29	23	28	28	40	41	34	82	24	38	39
Range	40	34	73	24	50	64	46	27	21	48	64	55	91	27	9	55	46
Grouping																	
Individual																	
Mean	8	39	0	52	46	53	8	12	56	51	9	38	15	4	51	44	30
Range	20	43	0	50	50	55	24	35	22	59	54	63	28	18	17	46	37
Small																	
Mean	22	0	41	0	0	0	46	59	0	2	22	0	16	0	0	0	13
Range	50	0	73	0	0	0	74	26	0	9	45	0	36	0	0	0	20
Large																	
Mean	58	44	49	36	44	32	29	23	28	27	40	41	34	82	24	38	39
Range	40	34	73	24	50	64	46	27	21	48	64	55	91	27	9	55	46
Materials																	
Paper and pencil																	
Mean	23	51	55	64	90	79	33	66	67	78	47	62	49	54	70	62	63
Range	50	27	82	57	0	9	4	27	13	10	46	19	72	18	33	18	30
Manipulative																	
Mean	35	26	55	4	41	35	56	72	0	10	5	1	9	44	0	10	25
Range	70	52	82	9	48	46	84	45	0	32	27	9	28	18	0	36	37
Game																	
Mean	0	0	0	0	0	0	0	0	0	0	22	0	14	0	0	0	2
Range	0	0	0	0	0	0	0	0	0	0	45	0	36	0	0	0	5
Printed material																	
Mean	0	3	0	0	0	18	0	33	0	0	0	0	2	0	0	0	4
Range	0	17	0	0	0	46	0	54	0	0	0	0	9	0	0	0	8

Note. Within each day, for each variable the upper number is the mean for all students observed and the lower number is the range across students.

[a]Means and ranges are percentages.

to the use of small groups. Generally, one teacher used small groups while the other used large groups. On days 3 and 7, most of the period was spent in small group activities in one class, explaining the large range of 74%. On day 8 small groups were used in both classes resulting in a mean percentage of allocated time of 59% and a relatively small range of 26%.

Materials. Paper and pencil materials (workbooks) were consistently used over both periods for an average of 58% of the allocated time. At least some paper and pencil materials were used each day (Table 6), generally more than 50% of the allocated time. Manipulatives were used in period A more than period B which may be the result of different topics being taught. There were daily variations in the use of manipulatives with some differences occurring between the two classes. On days 4 and 7 large ranges occurred among students in the amount of time spent using manipulatives because one group used them for most of the period while the other group did not use them at all. The manipulatives were links, counting rods, unifix cubes, and balances, mainly used along with the workbook. On occasion some manipulatives such as balances were used separately. Games requiring game boards were played on two of the observation days by one of the two groups of students. Some printed materials such as flash cards were used on four of the observation days for short periods of time.

Interactions. The pattern of interactions is very similar for each period involving close to 20% of the allocated time. Teacher to group was the primary form of interaction for both periods. Students talked directly to the teacher more in the first period than the second, but still only on the average of 1 minute per class period.

Summary. Teacher differences are apparent between the grade 2 teachers at school 440; one used more self-paced individual and small group activities while the other used mainly other-paced large group activities. Overall, large group activities were used consistently nearly 40% of the time. Small and individual groupings were used slightly more. The predominant materials used were paper and pencil and manipulatives. Printed materials and games were used only on an occasional day. The main interaction was the teacher talking to the group which occurred on the average of 5 minutes every class period. Other interactions seldom occurred.

Comparison of Grade 2 Classes in Schools 433 and 440

Certain commonalities between the two schools can be identified, but to attribute these to DMP or IGE is difficult. The length of the class period was nearly the same at both schools and ranged between 35 and 40 minutes. Three-quarters of this time was spent in activities related to specific mathematics objectives. At both schools paper and pencil materials were used approximately 60% of the allocated time. Manipulatives were used for nearly one-third of the time except during one observation period in school 440. This relatively high use of manipulative materials is most likely associated with DMP because of the emphasis placed by the program on their use. Games were seldom used at either school. The main type of interaction was teacher to group, occurring 11-14% of the time at both schools. The patterns of the other interaction types were very similar at both schools.

The main variations in instruction between the two schools were in pacing and grouping. These two means of instruction appear to be more associated with the teacher, as indicated by the differences between the instructional groups taught by the two teachers at school 440, than with either school or program variables. Variations in grouping and pacing also occurred from day to day, more at school 433 than school 440, indicating flexibility in their use. Also, within the instructional group of one teacher, some variation in pacing and grouping existed between individual students which suggests some individualization of instruction.

Grade 5

School 433

Thirteen observations were made of one grade 5 DMP class at school 433. The class contained approximately 25 students with 1 teacher and the length of the class period was 50 minutes. The teacher also taught math to the other half of the fifth graders during a different period. A range in abilities in the class was observed. Because some students had hearing impairments, the teacher wore a microphone during most of the class period.

Pacing and grouping. The average percentage of time spent in different pacing and grouping situations only fluctuated slightly between the two observation periods (Table 7). Overall, other-paced large group activities were observed about 50% of the allocated time. Self-paced and small group or individual activities were observed around 25% of the allocated time. The remaining part of the class period

Table 7

Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 433, Grade 5)

Variable	Period A (6 days)			Period B (7 days)			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
				Pacing					
Self	29	39	14	24	30	13	27	34	13
Other	46	61	22	58	70	29	52	66	26
				Grouping					
Individual	26	35	13	24	29	12	25	32	12
Small	4	5	2	2	2+	1	3	3	1
Large	45	60	21	56	69	29	51	65	25
				Materials					
Paper and pencil	60	80	29	64	78	33	62	79	31
Printed	10	14	5	0	0	0	5	6	2
Manipulative	8	11	24	8	10	4	8	10	4
Game	0	0	0	8	10	4	5	6	2
Other	2	3	1	0+[a]	0+	0+	1	1	1
				Interactions					
Target → Teacher	1	1	0+	1	1	1	1	1	0+
Teacher → Target	1	1	0+	0+	0+	0+	1	1	0+
Target ↔ Student	6	8	3	4	5	2	5	6	2
Target or Student → Group	0	0	0	2	3	1	1	2	1
Teacher → Group	19	25	9	27	32	14	23	29	11

Note. Average time per class day is 50 minutes.

[a] 0+ designates a positive value less than .5.

was spent in activities unrelated to math, such as band practice or management activities.

On a day-to-day basis (Table 8), with the exception of days 6, 8, 10, and 12, most class periods had some time devoted to self-paced activities and some time devoted to other-paced activities. On many of the days, small differences occurred among the students in grouping and pacing, indicating that most of the class members did the same activities. On a few occasions, mainly in period A, some students were in pairs for short periods of time. These were informal pairings where one student would ask a question or discuss the work briefly with another student while working in a self-paced individual situation. Formal grouping of students in pairs or small groups did not occur. Overall, the pattern of grouping and pacing in the grade 5 class at school 433 remained consistent across days and among students during a class period.

Materials. The use of paper and pencil materials (workbooks and worksheets) and manipulatives (rulers and bingo chips) remained consistent across the two periods. Paper and pencil materials were used 62% of the allocated time overall. Manipulatives were only used on 2 observation days, one each period. On day 8, in period B, chips were used to play bingo. Student guide books were used on 2 days in period A which accounts for the time spent using printed materials. The teacher would use an overhead projector to display examples and explanations of work and would occasionally have students use the projector to show their work. This use of the overhead projector by students was recorded as time spent with other materials. On a day-by-day

Table 8

Means and Ranges in Percentages for Means of Instruction Variables for each Observation Day (School 433, Grade 5)

Variable	Observation day: Period A 1	2	3	4	5	6	Period B 7	8	9	10	11	12	13	Mean over days
Pacing														
Self														
Mean[a]	43	36	36	28	28	21	33	9	39	15	47	21	28	30
Range[a]	12	21	11	[illegible]	5	0	7	8	8	14	28	12	37	15
Other														
Mean	40	40	37	52	62	70	61	85	56	80	34	76	50	57
Range	41	36	46	18	6	7	15	0	0	7	29	18	46	21
Grouping														
Individual														
Mean	40	37	31	19	28	21	31	9	39	15	47	21	26	28
Range	7	21	16	24	5	0	7	8	8	14	28	12	37	14
Small														
Mean	4	7	3	9	0	0	1	0	0	0	0	3	7	3
Range	13	22	22	23	0	0	7	0	0	0	0	18	21	10
Large														
Mean	38	35	37	52	62	70	61	85	56	80	34	73	45	56
Range	34	14	46	11	6	7	15	0	0	7	29	6	57	18
Materials														
Paper and pencil														
Mean	49	71	73	79	67	51	94	94	73	95	64	42	46	69
Range	20	21	52	48	12	7	15	7	7	7	28	18	39	22
Manipulative														
Mean	0	0	0	0	0	50	0	71	0	0	0	0	0	9
Range	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Game														
Mean	0	0	0	0	0	0	0	71	0	0	0	3	0	6
Range	0	0	0	0	0	0	0	0	0	0	0	18	0	1
Printed materials														
Mean	73	0	0	0	3	0	0	0	0	0	0	0	0	6
Range	38	0	0	0	11	0	0	0	0	0	0	0	0	4

Note. Within each day, for each variable the upper number is the mean for all students observed and the lower number is the range across students.

[a]Means and ranges are percentages.

basis (Table 8) paper and pencil materials were used regularly and for nearly the same amount of time among individual students. Other materials were only used occasionally.

Interactions. Interactions were observed occurring nearly 30% of the allocated time. Most of this time was spent with the teachers talking (discussing, explaining, or questioning) to the group. Nearly half of the large group time was spent with the teacher talking. Students were engaged in one-to-one interactions for 5% of the time. Other forms of interactions occurred but very infrequently.

Summary. The means of instruction used in the grade 5 DMP class at school 433 were very consistent. On almost every day some time (on the average of 50%) was spent with students in a large group paced by the teacher. The teacher was talking nearly half of this time. Then some time each day was spent with students working individually. Small groups were never observed being used and pairs of students only occurred informally. Paper and pencil materials were the primary materials with an occasional use of other materials, such as rulers, games (bingo), and student guides. On about a fourth of the days there were variations among activities of individual students, but generally all of the students did the same form of activity.

School 440

Three target students from each of the two groups of grade 5 students at school 440 were selected to be observed. Each group had approximately 23 students and 1 teacher. The two groups were located adjacent to each other in spaces formed by partitions and book shelves,

so that the observer could easily move between the two groups. The class period over the 16 observation days averaged 57 minutes.

Pacing and grouping. The pacing and grouping of students were consistent over the two periods (Table 9) with a total of 75% of the allocated time spent in self-paced individual and small group activities, and only 12% of the time spent in large group other-paced activities. The mean percent of time spent by students in self-paced activities by day (Table 10) was fairly consistent, ranging from 63 to 94%. Some differences occurred among individual students by day on self-paced activities. This can generally be explained by the differences between the styles of the two teachers. One teacher began the period discussing the lesson standing in front of the class and working examples on the blackboard before having the students work individually. The other teacher had the students work only individually using worksheets. Thus, most of the large group other-paced time was time spent by one of the two teachers. On an occasion some small groups and pairs were observed.

Materials. Paper and pencil materials (workbooks and worksheets) were used 80% of the allocated time. By day (Table 10) the mean percentage of students using paper and pencil materials varied from 72 to 96%. Variations by students were mainly due to the teacher rather than to adjusting instruction for individual students. Student guide books (printed material) were used in period A (19%), but very little in period B. Protractors and rulers (manipulatives) were each used 1 day in period A.

Interactions. Interactions occurred 13% of the time observed. The patterns of interactions varied somewhat from other classes in that

Table 9

Percent of Allocated and Available Times and Average Daily Time from Observations for Means of Instruction and Interaction Variables (School 440, Grade 5)

Variable	Period A (8 days)			Period B (8 days)			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
Pacing									
Self	77	86	46	72	86	39	75	86	43
Other	12	14	7	12	14	6	12	14	7
Grouping									
Individual	74	83	44	72	85	38	73	84	42
Small	3	3	2	1	1	1	2	2	1
Large	12	14	7	11	14	6	12	14	7
Materials									
Paper and pencil	84	94	50	76	90	41	80	92	46
Printed	19	21	11	5	6	3	12	14	7
Manipulative	8	9	5	0	0	0	4	5	2
Game	0	0	0	0	0	0	0	0	0
Other	1	1	0+[a]	2	3	1	2	2	1
Interactions									
Target → Teacher	2	3	1	2	2	1	2	3	1
Teacher → Target	3	4	2	3	4	1	3	4	2
Target ↔ Student	2	3	1	5	6	3	4	4	2
Target or Student → Group	0+	0+	0+	0+	0+	0+	0+	0+	0+
Teacher → Group	4	5	2	5	6	3	4	5	3

Note. Average time per class day is 57 minutes.

[a] 0+ designates a positive value less than .5.

Table 10

Means and Ranges in Percentages for Means of Instruction Variables for each Observation Day (School 440, Grade 5)

Variable	Observation day: Period A 1	2	3	4	5	6	7	8	Period B 9	10	11	12	13	14	15	16	Mean over days
Pacing																	
Self																	
Mean[a]	73	83	88	78	77	64	89	94	71	70	88	74	77	84	84	63	79
Range[a]	40	23	25	33	33	6	13	11	33	43	12	29	41	23	19	60	28
Other																	
Mean	17	8	4	12	16	34	5	5	15	22	0	15	11	9	6	26	13
Range	39	24	11	27	33	6	11	11	33	45	0	35	35	17	13	55	25
Grouping																	
Individual																	
Mean	70	83	88	78	58	64	89	94	71	70	88	74	77	82	84	63	77
Range	45	23	25	33	90	6	13	11	33	43	12	29	41	23	19	60	32
Small																	
Mean	4	0	0	0	20	0	0	0	0	0	0	0	6	2	0	0	2
Range	11	0	0	0	62	0	0	0	0	0	0	0	17	6	0	0	6
Large																	
Mean	17	8	4	12	16	34	5	5	15	21	0	15	7	9	6	26	13
Range	39	24	11	27	33	6	11	11	33	40	0	35	18	17	13	55	23
Materials																	
Paper and pencil																	
Mean	87	86	88	80	93	84	91	96	74	72	88	74	88	79	84	81	84
Range	17	6	25	33	22	35	7	11	33	31	12	43	12	29	19	23	22
Manipulative																	
Mean	0	0	0	0	0	32	0	36	0	0	0	0	0	0	0	0	7
Range	0	0	0	0	0	65	0	77	0	0	0	0	0	0	0	0	9
Game																	
Mean	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Range	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Printed material																	
Mean	0	27	30	19	8	53	25	0	0	0	0	0	0	26	0	14	13
Range	0	71	94	94	45	94	66	0	0	0	0	0	0	55	0	76	37

Note. Within each day, for each variable the upper number is the mean for all students observed and the lower number is the range across students.

[a]Means and ranges are percentages.

no more than 5% of the allocated time was spent with the teacher talking to the group which was slightly less than half the time spent in large group activities. A larger percentage of time was spent in one-to-one interactions involving either a teacher and a student or two students. As self-paced individual activities increased, students spent more time conversing directly with the teacher and less time listening to the teacher's explanations to the group as a whole.

Summary. The pattern of instruction for the grade 5 students at school 440 was very consistent over the investigative period with individual self-paced paper and pencil activities occurring 75% of the total time. There were some differences between the two teachers in the use of large groups, but still the primary means of grouping and pacing was individual self-paced. In addition to worksheets and workbooks, some student guides were used and, on an occasional day, protractors and rulers were used. Games were not used at anytime. Only one teacher spent any time speaking to the students in a large group. Most of the interactions occurred on a one-to-one basis.

Comparison of Grade 5 Classes in Schools 433 and 440

Very few commonalities were observed in the means of instruction for the grade 5 classes at the two schools. Paper and pencil materials were the main materials used in both schools, although to a much larger extent at school 440 than school 433. Very little use was made of small groups, manipulatives, or games at either school. The dissimilarities between the grade 5 classes at the two schools are numerous. Self-paced individual activities were used extensively at school 440, but only about a fourth of the time at school 433. The teacher at school 433

spent a large proportion of the allocated time talking to the whole group of students, whereas only one of the teachers at school 440 used any teacher to group interactions and usually for only 5 minutes at the beginning of the class period. Students at school 440 had more interactions with the teacher on a one-to-one basis.

Because of the large variance between the schools, there appear to be no commonalities in the means of instruction that can be related to the common curriculum program, DMP. The means appear to be more a function of the teacher or possibly the school and not so much the curriculum.

Comparisons Within Schools Across Grade Levels

Very few commonalities were found in the means of instruction for a grade level across schools using DMP. The differences appear to be strongly related to teacher effects or possibly school effects. In this section, the common means of instructions used in DMP classes at grade 2 and grade 5 within a school are discussed in an attempt to identify school effects.

The means of instruction used at school 433 in the grade 2 and grade 5 classes were very similar. The percentage of times spent for the pacing and grouping categories were almost identical with large group other-paced activities occurring 50% of the time. Differences in the use of manipulatives were observed; some of these were used nearly one-third of the time in grade 2 and very little in grade 5. Also, some printed materials (guide books) were used in grade 5 but not at all in grade 2. The patterns of interaction varied between

grade levels with the grade 5 teacher talking more to the group as a whole than the grade 2 teacher. Thus, there may be a possible school effect in the mixed use of large group other-paced and individual self-paced activities, but other means of instruction appear to be more teacher specific.

At school 440 very few similarities were found between the two grade levels. At grade 5 almost all of the time was spent in individual work whereas at grade 2 the time was divided among individual and large group activities. The proportion of time spent on different types of materials varied between grade levels as did the time spent on different interactions. Thus, in conclusion, no school effects were observed in the means of instruction used in DMP classes except for pacing and grouping at school 433.

V

TIME PROFILES

The two sources which provide information on classroom instructional time are the teacher logs and time sampling observations. The teacher logs provide an estimate of the amount of time which teachers allocated to mathematics objectives by day for the two 7-week periods. The logs were maintained for the same sample of six randomly selected target students that were observed. A more detailed discussion of the logging procedures and a summary of the log data are available in Project Papers 79-20 and 79-31 (Webb, 1979b and 1979l). The time sampling observations conducted on 12 to 16 days during the 17-week investigation period provide information on four types of time:

Nonapplied time - The time within a class period that is spent in activities that are not directly related to mathematics instruction (wait, transition, management, break, nonacademic, other-academic).

Available time - The amount of allocated classroom time actually spent on instruction of mathematics content (allocated time less nonapplied time).

Engaged time - The amount of available time which students spend actively learning mathematics content.

Nonengaged time - The amount of available time students are not actively involved with learning mathematics content (engaged time plus nonengaged time equals available time).

More detailed descriptions of the observation procedures, definitions, and unaggregated data are provided in Project Papers 79-32, 79-15, 79-18, and 80-1 (Webb, 1979a, j, k; Nerenz & Webb, 1980).

In this section of the report, time profiles are discussed using information from the observations and logs. The distribution of time across and within days is first considered, including profiles of the number of instructional days over the two observation periods and the percentage of allocated, available, and average daily time. Then the content covered is reported for each of the 11 general objectives by presenting the logged allocated time, available time from the observations, and an estimate of total engaged time for each period.

Grade 2

Distribution of Instructional Days

At both schools, the teacher logs were maintained for 14 weeks or 70 instructional days. How these days were used for mathematics instruction for the average student is shown in Table 11. The distribution of instructional days is almost identical between the two schools with only one exception--school 433 had one more day without mathematics instruction in period A, January to March. On the average, a student was absent one day out of each period. Thus, math instruction occurred on 62 days at school 433 and 63 days at school 440 over the period of investigation or for 89% of the possible days.

Allocated, Available, and Average Daily Time

School 433. The average daily useage of time during the mathematics period is shown in Table 12 for each period and the total period. The distribution of time for each period is very similar; 20% of the class period students were absent or nonapplied and 80% of the class period

Table 11

Average Distribution of Math Instructional Days
For Periods A and B and Total Period
(Schools 433 and 440, Grade 2)

	School 433			School 440		
	Period			Period		
	A	B	Total	A	B	Total
Total days possible	35	35	70	35	35	70
Number of days without math instruction	3	3	6	2	3	5
Number of days absent	1	1	2	1	1	2
Number of days with math instruction	31	31	62	32	31	63

Table 12

Percent of Allocated and Available Times and Average Daily Time From Observations For Instructional Time Variables (School 433, Grade 2)

Variable	Period A (7 days)			Period B (5 days)			Total period (12 days)		
	% of allocated time	% of available time	Average daily time for student (minutes)	% of allocated time	% of available time	Average daily time for student (minutes)	% of allocated time	% of available time	Average daily time for student (minutes)
Absent	7		2	3		1	5		2
Nonapplied time	13		14	17		6	15		5
Available time	80	100	28	79	100	28	80	100	28
Engaged time	52	65	18	58	73	20	55	68	19
Nonengaged time	28	35	10	21	27	8	25	32	9
Total time for math period			34			35			35

students were instructed on mathematics objectives (available time). Of the available time, slightly more time was spent engaged in period B (73%) than in period A (65%). Thus, on the average over the total period, of the 35 minutes in a mathematics class period, 28 minutes were available for mathematics instruction with 19 minutes spent actively engaged in learning.

School 440. The average daily time in mathematics grade 2 classes at school 440 (Table 13) varies slightly more between periods than for school 433. A larger percentage of nonapplied time was spent in period B (21%) than in period A (12%). This along with absences resulted in variance of the available time from 82% in period A to 74% in period B or a difference of about 3 minutes a day. Of the available time, the percentages of engaged time (60%) and nonengaged time (40%) are essentially identical between the two periods. Thus, on the average over the total period, of the 38 minutes in a mathematics period, 30 minutes were available for mathematics instruction with 18 minutes spent actively engaged in learning.

Contrasting the two schools, school 433 had slightly higher percentages of engaged time. However, since the class period was a little longer at school 440, the average daily engaged times were almost identical at the two schools--19 minutes for school 433 and 18 minutes for school 440.

Time Profile for Content Covered

Data were obtained initially for 31 objectives for grade 2 and for 34 objectives for grade 5. These objectives were aggregated into 11

Table 19

Time Allocation from Logs and Time Observed on General Objectives by Period (School 433, Grade 5)

General objectives	Period A					Period B					Total period	
	Log allocated time (minutes)	Number of minutes observed of 280 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Log allocated time (minutes)	Number of minutes observed of 357 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Allocated time logged (minutes)	Estimate of total engaged time (minutes)
1. Computes (+/-)	-	-	-	-	-	-	-	-	-	-	-	-
2. Numeration	-	-	-	-	-	-	34	75	-	-	-	-
3. Fractions-concept	900	119	68	462	51	430	39	80	282	66	1,330	744
4. Fractions-computation	600	97	75	337	57	200	114	74	121	61	814	458
5. Decimals-concept	25	-	-	-	-	50	-	-	-	-	75	-
6. Decimals-computation	-	-	-	-	-	570	97	70	329	58	570	329
7. Computes (X/÷)	-	-	-	-	-	-	-	-	-	-	-	-
8. Measurement attributes	-	-	-	-	-	-	-	-	-	-	-	-
9. Geometry	-	-	-	-	-	-	-	-	-	-	-	-
10. Problem solving	-	-	-	-	-	50	10	74	26	52	225	-
11. Miscellaneous	175	-	-	-	-	-	-	-	-	-	-	-

Table 13

Percent of Allocated and Available Times and Average Daily Time From Observations for Instructional Time Variables (School 440, Grade 2)

Variable	Period A			Period B			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
Absent	6		2	4		2	5		3
Nonapplied time	12		4	21		6	17		6
Available time	82	100	31	72	100	28	78	100	30
Engaged time	50	61	19	45	60	17	47	60	18
Nonengaged time	32	39	12	29	40	11	31	40	12
Total time for math period (minutes)			37			38			38

general objectives (see Figures 2 and 3). For each of the general objectives, information on the allocated time from the logs, observed time, percent of engaged time of the observed time, estimate of the total engaged time for the period (combination of the log and observation data), and estimate of the percentage of engaged time of the total log allocated time is provided for the schools separately.

School 433. For grade 2 at school 433 (Table 14) time was allocated to seven objectives in period A and five objectives in period B. Four of the five objectives in period B had time allocated in period A indicating a large carry-over of objectives between the two periods. The general objective with the most time allocated in period A was addition and subtraction computations for which the average student received 658 minutes of instruction or about the equivalent of 19 of the 35 days of instruction. The two general objectives with the next largest amount of allocated time were counting and inequalities, on which 236 minutes and 132 minutes were spent, respectively. The four other general objectives taking allocated time in period A equaled two class periods, or less than 7% of the total time allocated. Except for the miscellaneous objective, no instructional time was observed on these four objectives. The three primary objectives for school 433 had some instructional time observed in decreasing amounts, corresponding to the proportion of time allocated to the objective. This helps to substantiate that the sample of content observed was generally representative of all the content covered during the total period of investigation.

The percentage of engagement for the time observed for a general objective ranged from 61 to 100%. The two larger percentages, 82 and

Table 14

Time Allocation from Logs and Time Observed on General Objectives by Period (School 433, Grade 2)

General objectives	Period A					Period B					Total period	
	Log allocated time (minutes)	Number of minutes observed of 238 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Log allocated time (minutes)	Number of minutes observed of 173 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Allocated time logged (minutes)	Estimate of total engaged time (minutes)
1. Writes sentences (+/-)	77	-	-	0	0	286	29	86	195	68	363	195
2. Computes (+/-)	658	105	61	321	49	241	41	51	98	41	899	419
3. Counting	236	60	62	118	50	187	68	79	118	63	423	236
4. Inequalities	132	20	82	87	66	-	-	-	-	-	132	87
5. Fractions	25	-	-	-	-	189	-	-	-	-	214	-
6. Decimals	-	-	-	-	-	-	-	-	-	-	-	-
7. Computes (X/÷)	-	-	-	-	-	-	-	-	-	-	-	-
8. Measurement/ attributes	-	-	-	-	-	31	-	-	-	-	31	-
9. Geometry	-	-	-	-	-	-	-	-	-	-	-	-
10. Problem solving	11	-	-	-	-	-	-	-	-	-	11	-
11. Miscellaneous	52	6	100	42	81	-	-	-	-	-	52	42

100%, were for the objectives with the least amount of time and probably represent inflated values that would be lower if the objectives were observed for a longer period. The other two objectives, computes (+/-) and counting, had approximately 60% engaged which is close to the average percent engaged for the total period (55%) (Table 12). The estimates of the total engaged times for the general objectives are in the same order of time as the amounts of time allocated. The adjustment for engagement resulted in a reduction of total allocated time of from 49 to 66% for the three primary objectives.

In period B, four objectives were allocated 187 minutes or more which is equivalent to at least 5 days of instruction. Only five observations were made during the period which is reflected in the reduced number of minutes observed and the lower correlation between the observed and logged time. Although 189 minutes were logged for fractions, no time was observed for this general objective. The stability of the observation data in period B, because of the fewer number of observations, must be considered when interpreting the results.

Of the three general objectives observed, computes (+/-) had the lowest percentage of engagement which was also a decrease of 10% from the percentage of engagement in period A. One factor explaining the decrease was that the percentage of available time spent waiting during period B (43%) was almost twice the percentage of waiting time during period A (24%). This indicates a noticeable difference in the instructional approach between the two periods on addition and subtraction computations. The only other objective for which time was observed in both periods was counting. For this objective the percentage of engaged

time was greater in period B (79%) than period A (62%). Thus, some interaction was observed between content, the percent of engagement, and period. In fact, because of the differences between the percent of engagement for computes (+/-) and counting in period B, even though more time was allocated to the objective computes (+/-), the estimate of the total minutes engaged is less than what was estimated for counting. For the three objectives observed in period B, the adjustment for engagement resulted in an estimated percentage of allocated time of from 41 to 68%, a slightly larger range than for period A.

School 440. For grade 2 at school 440 (Table 15), time was allocated to seven general objectives in period A and period B. Only one objective, geometry, had time allocated in period A, but did not have time allocated in period B. The four main general objectives in period A were counting (413 minutes), addition and subtraction computations (314 minutes), measurement/attributes (183 minutes), and writes joining and separating sentences (147 minutes). In period B, instructional time was allocated to these same objectives but with different emphases--addition and subtraction computations received the most time followed by measurement/attributes.

The time observed is generally representative of the time allocated to the objectives for both periods. In period A, the percent of engagement ranged from 53 to 74% with the larger percentages occurring for the objectives observed less frequently. For the four primary objectives, the percent of engaged time ranged from 53 to 60% indicating very little interaction between objective and engagement. When the allocated times are adjusted for engagement, the estimated percents of engagement ranged from 44 to 60%.

Table 15

Time Allocation from Logs and Time Observed on General Objectives by Period (School 440, Grade 2)

General objectives	Period A					Period B					Total period	
	Log allocated time (minutes)	Number of minutes observed of 303 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Log allocated time (minutes)	Number of minutes observed of 302 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Allocated time logged (minutes)	Estimate of total engaged time (minutes)
1. Writes sentences (+/-)	147	17	54	66	45	97	0	-	-	-	244	66
2. Computes (+/-)	314	66	53	138	44	521	116	67	260	50	835	398
3. Counting	413	106	60	204	49	81	3	68	41	51	494	245
4. Inequalities	70	24	74	42	60	27	9	48	10	37	97	52
5. Fractions	-	-	-	-	-	-	-	-	-	-	-	-
6. Decimals	-	-	-	-	-	-	-	-	-	-	-	-
7. Computes (X/÷)	-	-	-	-	-	6	-	-	-	-	6	-
8. Measurement/ attributes	183	10	55	83	45	251	70	56	104	41	434	187
9. Geometry	23	23	71	13	56	-	-	-	-	-	23	13
10. Problem solving	-	-	-	-	-	-	-	-	-	-	-	-
11. Miscellaneous	67	2	71	39	58	145	27	43	46	32	212	85

In period B, the percent of engagement for the primary objectives (more than 80 minutes of allocated time) was generally either the same or higher than for period A. The miscellaneous objective had a lower percent of engagement (43%). This was lower than expected considering the percent of engagement for the other objectives in both periods. When the allocated times were adjusted for engagement the estimated percentages of engagement ranged from 32% (miscellaneous) to 51% (counting).

Comparison of Schools 433 and 440. In comparing the total allocated time for the total period on the two primary objectives, addition and subtraction computation and counting, the two schools are very similar. Addition and subtraction computation was allocated the most time. How the time was allocated during the two periods, however, differed between the two schools. School 433 spent more time in period A whereas school 440 spent closer to the same amount of time in each period with the greater amount of time being spent in period B. For counting, nearly the same amount of time was spent during both periods at school 433, whereas at school 440 most of the time allocated to counting was in period A. Thus, one difference between schools is the sequence in which instruction is given. A second difference is that school 440 spent a significant time on measurement/attributes (topics 34 and 36) and some time on geometry, whereas at school 433 only 31 minutes in period B was spent on measurement with no time being spent on geometry. On the other hand, school 433 spent more time on writing sentences and fractions. Even though DMP is used at both schools there are differences in which objectives are accorded instructional time and in the sequence of

instruction. The teacher at school 433 has chosen to give instruction on the "core" objectives. The teachers at school 440 have chosen to use the topics in sequence.

In comparing the estimate of the total amounts of time spent engaged in instruction on an objective, some of the differences between the time allocated to the objectives are reduced. For example, on addition and subtraction computation the difference between the two schools in allocated time is 64 minutes. When adjusted for engagement the difference is only 22 minutes. Thus, if the amount of engaged time spent on an objective is a strong predictor of gain in achievement, after adjusting for initial achievement, there should be similar gain scores on this objective for both schools.

Grade 5

Distribution of Instructional Days

At both schools, the teacher logs were maintained for 14 weeks for a total of 70 instructional days (Table 16). Because of the time that spring break was taken, logs were maintained for grade 5 at school 433 40 days in period A and 30 days in period B. No absences were recorded on the logs at school 433, so estimates of these days were made using the percent of absences from the observations. For school 433, of the 70 possible days, 54 included math instruction. This is 1 week less than the number of days with math instruction at school 440. Two reasons for the variance are that at school 433 students had a higher rate of absences and there were more days without any mathematics instruction.

Table 16

Average Distribution of Math Instructional Days
For Periods A and B and Total Period
(Schools 433 and 440, Grade 5)

	School 433			School 440		
	Period			Period		
	A	B	Total	A	B	Total
Total days possible	40	30	70	35	35	70
Number of days without math instruction	6	4	10	2	5	7
Number of days absent	3[a]	3[a]	6	2	2	4
Number of days with math instruction	31	23	54	31	28	59

[a]These are estimates of the number of days absent using information from the observations.

Allocated, Available, and Average Daily Time

School 433. The average daily usage of time during the mathematics period is shown in Table 17 for periods A and B and their total. The usage of time is very similar to that reported for the grade 2 classes. A slightly larger percentage was spent in nonapplied time in period A, which lowered the percentage of available time to 75%. Contributing to the 17% of nonapplied time in period A was 7% of the time spent in transition and 6% of the time spent by two students in band practice. For the total period, 79% of the time was available for activities directly involved with mathematics content. Of this available time, the percentages of engaged time and nonengaged time are consistent across periods with percentages for the total period being 72% and 20%, respectively. Thus, of the 50 minutes allocated for a mathematics period, 39 minutes was available for mathematics instruction with 28 minutes actually spent with students actively engaged in learning.

School 440. The average daily time for mathematics for grade 5 at school 440 is shown in Table 18. The percentages of available time were higher for these classes than for the others. The total percentage of absences and nonapplied time for period A was 10%, about half the percentage of time spent in other classes. This percentage was higher in period B (16%) but still lower than for the other classes. The result of these lower percentages of nonapplied time is a relatively high percentage of available time. As discussed in Chapter IV, the means of instruction for grade 5 at school 440 was largely self-paced individual activities. This is probably one reason for the smaller amount of nonapplied time. In this situation, students were familiar with the

Table 17

Percent of Allocated and Available Times and Average Daily Times from Observations for Instructional Time Variables (School 433, Grade 5)

Variable	Period A			Period B			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
Absent	8		4	9		4	9		4
Nonapplied time	17		8	9		4	12		6
Available time	75	100	36	82	100	42	79	100	39
Engaged time	54	71	26	60	73	31	57	72	28
Nonengaged time	21	29	10	22	27	11	22	28	11
Total time for reading skills period			48			50			50

Table 18

Percent of Allocated and Available Times and Average Daily Times From Observations for Instructional Time Variables (School 440, Grade 5)

Variable	Period A			Period B			Total period		
	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)	% of allocated time	% of available time	Average daily time per student (minutes)
Absent	4		2	6		3	5		3
Nonapplied time	6		4	10		5	8		4
Available time	90	100	54	84	100	45	87	100	50
Engaged time	60	66	36	56	67	30	58	67	33
Nonengaged time	30	33	18	28	33	15	29	33	17
Total time for math period			60			53			57

routine, which was mainly distributing workbooks or worksheets at the beginning of the period, so students began to work without a large amount of time spent in transition. However, the percentage of available time spent engaged was slightly lower for these fifth-grade classes than for the grade 5 class at school 433, 67% compared to 72%. It appears that even though students who work mainly in self-paced individual activities have an increased percentage of available time, the percentage of engagement is slightly lower. In grade 5 at school 440 in mathematics, the class period averaged 57 minutes. Of this time, 50 minutes was available for work in mathematics content with 33 minutes being spent with students engaged. There was a difference of 11 minutes between the two schools in the minutes available for mathematics instruction. However, because of the lower rate of engagement at school 440, the difference between the two schools in engaged time was 5 minutes.

Time Profiles by General Objective

For grade 5, 34 basic objectives were aggregated into 11 general objectives as shown in Figure 3. The total time allocated for one student as reported on the logs, the number of minutes observed, the percent of engaged time from the observations, an estimate of the total engaged time, and an estimate of the percent of engaged time are reported for each of the 11 objectives separately for the two schools.

School 433. In period A time was mainly allocated to fractions (Table 19), with only a small amount of time spent on miscellaneous work (other computations such as percents and averages) and the concept of

decimals. Instruction was observed only on fractions-concept and fractions-computation. The percentages of engagement on both objectives were similar, 68% and 75%, and resulted in a total estimate of 462 minutes of engaged time over the period for fractions-concept and 337 minutes for fractions-computation. These are the equivalent of approximately 10 days and 7 days of instruction, respectively.

In period B, the largest amount of time was allocated to decimals-computation with a significant proportion of time spent on fractions-concept and fractions-computation. As in period A some time was spent on decimals-concept and miscellaneous work. The relative proportion of time observed for each objective varies slightly from the relative proportion of the logged allocated time, which implies that the observations were less than a representative sampling of all of the instructional time. The percentages of engagement were about the same in period B as in period A, varying between 70% and 80%, except for the miscellaneous objective. The nigher estimates of the percentages of engagement for the objectives in period B reflect both the rate of engagement as well as the reduced percentage of nonapplied time. For grade 5 at school 433 there is little interaction between objective and engagement.

School 440. The allocated time was dispersed over eight general objectives in period A (Table 20). Computing by multiplying and dividing was the predominant objective, receiving nearly 60% of the allocated time, with the rest of the time spread among the other seven general objectives. One teacher had students use worksheets which contained problems from a wide variety of content areas. This is one explanation

Table 20

Time Allocation from Logs and Time Observed on General Objectives by Period (School 440, Grade 5)

General objectives	Period A					Period B					Total period	
	Log allocated time (minutes)	Number of minutes observed of 479 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Log allocated time (minutes)	Number of minutes observed of 430 minutes	% engaged of observed available time	Estimate of total engaged time (minutes)	Estimate % engaged of log allocated time	Allocated time logged (minutes)	Estimate of total engaged time (minutes)
1. Computes (+/-)	-	2	100	-	-	-	3	100	-	-	-	-
2. Numeration	74	21	61	40	54	-	-	-	-	-	74	40
3. Fractions-concept	58	4	55	29	50	726	86	69	422	58	784	451
4. Fractions-computation	26	0	-	-	-	201	146	59	101	50	227	101
5. Decimals-concept	24	2	96	20	83	-	-	-	-	-	24	20
6. Decimals-computation	-	-	-	-	-	87	12	79	58	67	87	58
7. Computes (X/÷)	1,020	261	69	628	62	29	42	84	20	69	1,049	648
8. Measurement/ attributes	-	-	-	-	-	-	-	-	-	-	-	-
9. Geometry	73	26	70	6	63	50	5	67	28	56	123	174
10. Problem solving	148	24	44	59	40	-	-	-	-	-	148	59
11. Miscellaneous	226	89	63	128	57	256	98	63	137	54	482	265

for the large number of general objectives with allocated time. The proportion of time observed by objective is representative of how the time was allocated.

Discounting the objectives on which a very small amount of time was observed, the percentages of engagement observed generally ranged from 60% to 70%, slightly lower than for school 433. However, because of the lower percentage of nonapplied time at school 440, the estimated percentages of engagement for the primary objectives, computes, are slightly higher.

In period B, some time was allocated to six general objectives. The objectives with the most time were fractions-concept, miscellaneous, and fractions-computation. Although in period A most of the instructional time was spent on multiplication and division, in period B most of the time was spent on fractions. One noticeable discrepancy between the log and the observation data is that more time was observed on computes (x/÷) than was logged. The distribution of percentages of engagement in period B is similar to that for period A. The percentage of engagement of 84% for computes (x/÷) in period B is relatively high. The range of the estimates of the percent of engaged time, 50% to 67%, in period B is smaller than the range in period A, but the average estimates of percent for both periods are very similar equaling nearly 60%. For grade 5 at school 440 there was little interaction between the general objectives and engagement. Large percentages of engaged time were generally associated with small amounts of time for the objective being observed. For the objectives having a significant amount of logged allocated time, the estimated engaged rates generally fell in the range of 50% to 60%.

Comparison of the Content Covered by School 433 and School 440. The two schools differed noticeably in the content covered during the two periods of investigation. At school 433 instruction was confined to two general objectives--fractions in period A and fractions and decimals in period B. Only one teacher and one class were observed, which helps to explain the restriction of instruction to a few general objectives. The teacher commented that he prefers to teach the topics related to one strand, such as fractions, rather than take the topics in numerical sequence. In contrast, at school 440 where two classes participated in the study, instructional time was spent on a range of general objectives. However, during each period one general area received the major part of classroom time. In period A this topic was multiplication and division computations and in period B it was fractions.

The differences between the two schools in the range of content areas given some instructional time reflect differences in the individualization of instruction at each school. It was reported in Chapter IV that the primary mode of instruction for grade 5 at school 433 was large group-teacher paced. For grade 5 at school 440, self-paced individual work occured a large proportion of the time. During the individual activities students were involved in instruction on different content areas, as can be seen in Project Paper 79-20 (Webb, 1979b). During period A at school 440, some instructional time was spent on 14 DMP topics between Topic 52 and Topic 77. In period B, some instructional time was spent on 14 DMP topics, from Topic 60 to Topic 77. In contrast, at school 433, instructional time was spent only on DMP topics

67, 71, and 81 in period A and topics 81 and 84 in period B.

Non-DMP materials were used at both schools with a greater use of these materials occurring in period B. At school 433, non-DMP materials were used 3% of the time in period A and 31% of the time in period B. At school 440, non-DMP materials were used .2% of the time in period A and 55% of the time in period B. The non-DMP materials used were worksheets and workbooks taken from other commercial sources or made by the teacher. As the school year progressed the trend was to use these materials to provide the students more practice of skills. The two teachers at school 440 differed considerably in the use of non-DMP materials. One teacher used DMP materials almost exclusively. The other teacher used only non-DMP materials during all of period B. Thus, the use of non-DMP materials or the adaptation of DMP appears to be more a decision of the teacher than of the school.

The percentage of engagement at both schools was similar and averaged approximately 70% of the available time. The estimate of the percentage of engaged time of the time logged was also similar and averaged 60%. Thus, the variance in content covered was due more to what time was allocated to particular general objectives than to variance in the amount of engagement of students during classes.

In conclusion, even though both schools were using DMP as the main mathematics program at grade 5, the use of the program varied greatly. This indicates flexibility in the use of DMP. At neither school was DMP used exclusively. Individualization and adapting the materials to meet the needs of individual students was done more at school 440 than 433. The engagement rate varied very little between the

two schools. Because of the fewer days without mathematics instruction and the larger class periods, students at school 440 received more instruction in mathematics than did students at school 433.

VI

ACHIEVEMENT PROFILES

In this chapter information on achievement collected at the beginning of the period of investigation (January) and at the end of each 7-week period of observation (March and May) will be discussed. In the following chapter the relationship between the instructional time variables and achievement will be explored.

The two means of assessing achievement at the three occasions were achievement monitoring tests and domain referenced tests. A matrix sampling procedure was used in administering the achievement monitoring tests, which were designed to provide measures of achievement for the group of students over a range of objectives. The four test forms were composed of items representing 19 basic objectives for grade 2 and 14 basic objectives for grade 5. When the objectives were aggregated, achievement data were available for seven grade 2 general objectives and six grade 5 general objectives. The objective easiness (percent correct) for the aggregated data for each objective is given separately for grades 2 and 5. More detailed descriptions of the achievement monitoring procedure and results for the basic objective are given in Project Papers 79-1, 4, 7 (Webb, 1979g, h, i).

Domain referenced tests were used to provide detailed information on three basic objectives for each grade level. The objectives tested using this procedure were selected based upon their general importance to the mathematics curriculum and the ease of defining the domain of items to test the objective. For each test time 10 items were randomly

selected from the specified domain of all possible items for each objective. All students took the same test form at a particular test time. An analysis procedure developed by Harris and Pearlman (1978) was used to provide an index of the domain difficulty ($\hat{k}$) as well as an index of item difficulty for each item. The domain difficulty index theoretically represents the facility that students had with the general concepts and ideas associated with the objective. The mean, standard deviation, and domain difficulty for each objective tested are given separately for grades 2 and 5. A more detailed description of analyses and the results of the domain referenced tests are given in Project Papers 79-9, 11, 13 (Webb, 1979d, e, f).

First we will discuss the results of the achievement measures for grade 2, and second the results for grade 5. Included in each discussion will be a comparison of the six target students to the total group of students tested at each school to provide an indication of how representative the sample of target students was of the total group.

Grade 2

Achievement Monitoring Tests

School 433. The only objective on which grade 2 students at school 433 had relatively high scores (.80 or above) for the initial testing was inequalities (Table 21). The objective easiness on the other six objectives ranged from .32 to .68. The major growth on fractions took place over period A, between test time 1 and 2. For two objectives, computes (+/-) and measurement/attributes, large increases in achievement occurred over period B. The achievement on the remaining objectives

Table 21

Objective Easiness and Gain Over Total Period on
General Objectives from Achievement Monitoring Tests
(Grade 2)

General objective	School 433				School 440			
	Test time 1 (January) (n=30)	Test time 2 (March) (n=29)	Test time 3 (May) (n=31)	Gain (T3-T1)	Test time 1 (January) (n=55)	Test time 2 (March) (n=58)	Test time 3 (May) (n=57)	Gain (T3-T1)
01 Writes sentences (+/-)	.61	.69	.75	.14	.33	.41	.48	.15
02 Computes (+/-)	.45	.47	.64	.19	.24	.31	.44	.20
03 Counting	.68	.74	.81	.13	.60	.69	.70	.10
04 Inequalities	.80	.90	.87	.07	.73	.86	.82	.09
05 Fractions	.32	.72	.82	.50	.46	.42	.48	.02
08 Measurement/ attributes	.33	.24	.61	.28	.25	.24	.42	.17
10 Problem solving	.38	.41	.52	.14	.39	.11	.36	-.03

generally increased monotonically over both periods. All of the objectives had positive gains between test time 1 and 3 with the fractions having the largest gain score. The objective easiness was above .80 for test time 3 on three objectives--counting, inequalities, and fractions. Thus, grade 2 students at school 433 progressed in achievement on all general objectives and made fairly large increases on fractions over period A and on computes (+/-) and measurement/attributes over period B.

School 440. The range of test scores for test time 1 at school 440 is similar to the range of scores for test time 1 at school 433. The scores, however, are generally lower. As for school 433, grade 2, students scored the highest for test time 1 on inequalities followed by counting (Table 21). The two objectives with the lowest initial scores were computes (+/-) and measurement/attributes. Over the total period of investigation there were positive gain scores for all objectives except problem solving. The gain scores for writes sentences, computes (+/-), and counting are very similar to those for school 433. Noticeable increases in achievement were made on some of the objectives over one of the two observation periods. The largest increases in achievement on counting and inequalities occurred over period A. The largest increases in computes (+/-) and measurement/attributes occurred over period B. Achievement gains on write sentences (+/-) were the same over both periods indicating steady growth on this objective. Achievement gains on the other two objectives, fractions and problem solving, fluctuated between the two periods without any significant gain over the total period. The relation of the pattern of achievement by period to time spent on instruction is discussed in the next chapter.

Domain Referenced Tests

School 433. Scores on the domain referenced tests for the grade 2 students tested at school 433 (Table 22) indicate that the students understood the general concepts and ideas related to each of the three objectives. The indices of domain difficulty were generally above .90 for all of the test times. The increase in mean scores between test times indicates that students made progress on each of the basic objectives over the total period. For test time 3 the percentage of students answering correctly all of the items for an objective ranged from 34% on writes numbers 0-99 to 56% on writes difference sentence 0-20. The distribution of scores and the high percentage of students with perfect scores provides evidence that the students tested were fairly homogeneous in their performance on the three objectives with little variation in achievement within the group.

School 440. Grade 2 students at school 440 demonstrated understanding of the general concepts and ideas related to counting and writing numbers 0-99 for each of the test times. The domain difficulties were all above .90. Even though these are comparable to the domain difficulties for students at school 433, students at school 440 had more difficulty on specific items, which resulted in lower percent corrects on one or two items and lower means. In particular, students had more difficulty counting objects arranged by 6's or 7's than items grouped by 5's or 10's.

Students at school 440 scored lower on writing difference sentences than they did on the other two objectives. However, the group made progress on the objective over the period of investigation with an increase of 2.07 in mean score. There was some variation among the scores.

Table 22

Mean, Standard Deviation, and Domain Difficulty on Three Basic Objectives from Domain Referenced Tests (Grade 2)

Basic objective		School 433 Test time 1 (January) (n=79)	School 433 Test time 2 (March) (n=29)	School 433 Test time 3 (May) (n=32)	School 433 Gain (T3-T1)	School 440 Test time 1 (January) (n=55)	School 440 Test time 2 (March) (n=58)	School 440 Test time 3 (May) (n=57)	School 440 Gain (T3-T1)
Writes numbers 0-99	Mean	7.76[a]	7.28	8.44	.68	6.98	6.66	7.75	.77
	(SD)	(2.34)	(2.48)	(1.70)		(2.42)	(2.56)	(1.64)	
	$\hat{k}^b$	.94	.92	.98		.92	.90	.98	
Writes difference sentence 0-20	Mean	6.45[a]	7.79	8.44	1.99	4.18	5.43	6.25	2.07
	(SD)	(3.64)	(2.77)	(2.66)		(3.13)	(3.36)	(3.82)	
	$\hat{k}^b$	.78	.90	.92		.68	.75	.74	
Solves open sentence 0-20	Mean	7.10[a]	7.90	8.50	1.40	3.87	5.79	6.54	2.67
	(SD)	(2.94)	(2.14)	(1.95)		(2.61)	(2.29)	(2.95)	
	$\hat{k}^b$	.87	.95	.96		.74	.90	.85	

[a] Score of 10 is possible on each objective, one point for each item.

[b] $\hat{k}$ is the domain difficulty calculated using a procedure developed by Harris and Pearlman (1978).

The distribution of students at test time 3 was bimodal with a third of the students having scores less than five. The indices of domain difficulty indicate that, in general, the group had difficulty with the concept of writing difference sentences. However, as indicated by the increase in the index from test time 1 to test time 3, students made progress over the total period.

For test time 1 the scores were low on solving open sentences 0-20 with a mean score of 3.87 and a domain difficulty index of .74. A substantial increase in scores was made over the total period. In general, at test time 3, a group of students had some understanding of the underlying concepts, although many students still had difficulty with specific problems of the form 15 = □ - 4. The distribution of scores on solving open sentences was not as great or as polarized as the distribution of scores on writing difference sentences, but the scores still varied widely.

A variation in achievement existed in the domain referenced test scores for students from school 440 that did not exist for students from school 433. One reason is that only one class of students in the middle range of abilities were tested from school 433 whereas all the grade 2 students at school 440, divided into two classes, were tested. The variation of scores is particularly evident on the objective writing difference sentence 0-20. A second possible reason for the difference between the two schools, that will have to be verified by consulting the observation and log data, is that instruction at school 440 is more individualized so that only part of the students received instructional time on writing difference sentences while instructional time for other students was spent on other objectives.

Target Students vs. Total Group

In Table 23 a comparison is made of the domain referenced tests mean scores for the total group of students with the scores for the six target students who were observed and logged. At both schools the means for the target students are higher than for the total group for nearly every test time for each of the three objectives. The standard deviations for the target students at school 433 are smaller, in general, than are the ones for the total group indicating that the range in scores for the target students is not as large as the range in scores for the total group. At school 440 the standard deviations show that the target students' range in scores generally matched the range in scores for the total group. Thus the target students at school 440 are more representative of the total group than the target students at school 433.

Contrast Between Schools on Achievement

From the achievement scores for both the achievement monitoring tests and domain referenced tests for test time 1, it is evident that the students tested at school 433 began the period of investigation at a higher or a comparable level of achievement on all objectives, except for fractions, than did the students at school 440. These same differences were apparent at test time 3 except on the objectives fractions, measurement/ attributes, and problem solving on which students at school 433 made larger gains over the total period. Thus the achievement curves for each school generally were parallel for most objectives tested by either means of testing.

Some increase in achievement was made on all objectives by both schools except on problem solving by school 440. The patterns of

Table 23

Comparison of Total Group and Target Students on Means for Three Basic Objectives from Domain Referenced Tests for Three Test Times by School (Grade 2)

Basic objective		School 433 Test time 1 (January)	School 433 Test time 2 (March)	School 433 Test time 3 (May)	School 440 Test time 1 (January)	School 440 Test time 2 (March)	School 440 Test time 3 (May)
Writes number 0-99							
Total group	Mean	7.76	7.28	8.44	6.98	6.55	7.75
	(SD)	(2.34)	(2.48)	(1.70)	(2.42)	(2.56)	(1.64)
Target students	Mean	8.00	8.00	9.50	7.83	6.67	7.33
	(SD)	(2.10)	(1.26)	(.84)	(2.32)	(3.20)	(1.37)
Writes difference sentence 0-20							
Total group	Mean	6.45	7.79	8.44	4.18	5.43	6.25
	(SD)	(3.64)	(2.77)	(2.66)	(3.13)	(3.36)	(3.82)
Target students	Mean	7.33	8.67	9.67	4.67	6.67	7.00
	(SD)	(3.78)	(1.75)	(.52)	(4.13)	(3.39)	(4.10)
Solves open sentence 0-20							
Total group	Mean	7.10	7.90	8.50	3.87	5.79	6.54
	(SD)	(2.94)	(2.14)	(1.95)	(2.61)	(2.29)	(2.95)
Target students	Mean	7.33	8.83	9.17	5.50	6.83	7.17
	(SD)	(1.97)	(1.60)	(.98)	(2.66)	(2.79)	(3.19)

achievement are similar between the two schools on writing sentences, computes (+/-), counting, inequalities, and measurement/attributes which can be partially explained by both schools using DMP. The schools differed in the increase of achievement on fractions and problem solving where students from school 433 had greater gains. The distribution of scores for school 433 on the domain referenced tests over the three test times approached the shape of mastery curves where a large proportion of students were grouped around 80% or higher. The achievement scores for school 440 were more dispersed, indicating a more heterogeneous group. Whereas most of the students tested at school 433 appeared to understand the underlying concepts of the three basic objectives tested using the domain referenced procedure, some students at school 440 experienced problems on one objective, writing difference sentences. On the other two objectives the domain difficulty indices indicate that the students understood the related concepts. However, on particular items, such as counting by 6's or 7's, students from school 440 had more difficulty than students from school 433. The relationship of the differences to information from the observations and the logs will be discussed further in Chapter VII.

Grade 5

Achievement Monitoring Tests

School 433. The objective easiness scores for the objectives for test time 1 (Table 24) show that the group of students from school 433 at the beginning of the investigation period had some competency in multiplication and division computation. Scores on all of the other objectives were less than .50 and were particularly low on decimals-computation and

Table 24

Objective Easiness and Gain Over Total Period on General Objectives From Achievement Monitoring Tests for Three Test Times by School (Grade 5)

General objectives	School 433 Test time 1 (January) (n=41)	School 433 Test time 2 (March) (n=42)	School 433 Test time 3 (May) (n=42)	School 433 Gain (T3-T1)	School 440 Test time 1 (January) (n=46)	School 440 Test time 2 (March) (n=48)	School 440 Test time 3 (May) (n=48)	School 440 Gain (T3-T1)
03 Fractions-concepts	.37	.89	.82	.45	.54	.60	.72	.18
04 Fractions-computation	.28	.71	.63	.35	.48	.54	.64	.16
05 Decimals-concepts	.48	.51	.56	.08	.63	.58	.54	-.09
06 Decimals-computation	.16	.12	.49	.33	.25	.20	.24	-.01
07 Computes (x/÷)	.67	.64	.69	.02	.49	.64	.62	.13
10 Problem solving	.17	.33	.27	.10	.20	.25	.28	.08

problem solving. Substantial gains were made over the total period on three objectives--fractions-concepts, fractions-computation, and decimals-computation. Small gains were made on the other three objectives, so at least some increase in achievement was made on all objectives. The gain in achievement on the two fraction objectives occurred over period A with some attrition in scores during period B. The gain in achievement on decimals-computation occurred over period B. On the final test time, the scores were high in fractions-concepts and moderately high on fractions-computation and computes (x/÷). Thus students tested at school 433 showed advancement on all of the objectives and obtained a moderately high level of competency on half of them.

School 440. Overall the test time 1 objective easiness scores for grade 5 students at school 440 were higher than the scores of students at school 433. Students at school 440 scored lower only on computations using multiplication and division. On the initial testing school 440 students scored moderately high on decimals-concepts. The two objectives with the lowest scores, as in school 433, were decimals-computation and problem solving. Over the total period moderate gains were made on three objectives--fractions-concepts, fractions-computation, and computes (x/÷). The major gains on each of these objectives were made over one period, period A for computes (x/÷) and period B for the two fractions objectives. Small but steady increases in achievement on problem solving were made over both periods whereas scores on decimals-concepts declined slightly. For test time 3, as at school 433, students scored the highest on the two fractions objectives. The objective easiness scores for test time 3 on fractions-computation, decimals-concepts, and problem

solving were almost identical for both schools. Thus the higher scores school 440 had at test time 1 were not maintained over the period of investigation. The test time 3 scores for both schools were the same on three of the objectives and on two other objectives were higher for school 433.

Domain Referenced Tests

School 433. With the exception of the mean score for finds equivalent common fraction or mixed number for test time 1 (Table 25), all of the mean scores are relatively high. The distributions of scores on the multiplication and division objectives, reflect mastery curves with a large number of students with scores of 9 or 10. The domain difficulty indices indicate that generally students understood the concepts associated with each of the three objectives. Over the total period very little increase was made in achievement on multiplication and division which corresponds to the results for the achievement monitoring tests on the objective computes (x/÷). However, a few students (34%) still had some problems with division and scored 5 or less. A large gain occurred in achievement over the total period on finding equivalent fractions. This corresponds to the emphasis placed on this objective during instruction (Table 19, and to the results from the achievement monitoring tests.

School 440. Achievement on multiplication did not vary greatly over the three test times. The domain difficulty indices of approximately .90 indicates that the students understood the general concept of multiplication. The one item that students had the most difficulty with on test time 3 was 852 x 6. On all of the other items, the percent correct was consistently high.

Table 25

Mean, Standard Deviation, and Domain Difficulty on Three Basic Objectives from Domain Referenced Tests (Grade 5)

Basic objective		School 433 Test time 1 (January) (n=41)	School 433 Test time 2 (March) (n=29)	School 433 Test time 3 (May) (n=41)	School 433 Gain (T3-T1)	School 440 Test time 1 (January) (n=46)	School 440 Test time 2 (March) (n=58)	School 440 Test time 3 (May) (n=47)	School 440 Gain (T3-T1)
Finds product 0-9,999	Mean	8.22	7.28	8.49	.27	7.83	6.58	8.15	.32
	(SD)	(2.17)	(2.48)	(1.90)		(3.02)	(2.56)	(2.40)	
	$\hat{k}$	.95	.92	.97		.88	.90	.93	
Finds equivalent common fraction or mixed number	Mean	3.85	7.79	8.71	4.86	5.67	5.43	6.62	.95
	(SD)	(2.56)	(2.77)	(2.14)		(4.17)	(3.36)	(3.25)	
	$\hat{k}$	.72	.90	.95		.66	.75	.83	
Divides by 1-digit number	Mean	6.68	7.90	7.02	.34	4.91	5.79	6.60	1.69
	(SD)	(3.51)	(2.14)	(3.34)		(3.83)	(2.29)	(3.12)	
	$\hat{k}$	.80	.95	.83		.64	.90	.84	

On the objective finds equivalent common fraction or mixed number there was some gain in achievement over the total period. The distribution of scores for the three test times on this objective was bimodal with a number of students having perfect scores and a number of students having scores of 1 or 0. The students generally had a moderate level of understanding of the related concepts as indicated by the domain difficulty indices. Students from school 440 had more difficulty with items involving mixed numbers than did students from school 433, which could be the result of different instructional approaches at the two schools.

The largest increase in mean score of the three objectives occurred on the objective dividing by a 1-digit number. For test time 1 the scores were widely distributed from 0 to 10 with a mean score of less than 5. For test time 3, some students still had difficulty with division, although 80% of the students had scores of 5 or above. The domain difficulty index of .84 for test time 3 is moderately high indicating general understanding of division by the group. By combining the information from the achievement monitoring tests and the domain referenced tests it appears that much of the increase in the general objective computes (÷) was due to the increase in the ability of students to do division.

Comparison of Target Students to Total Group

The means and standard deviation for the total group and six target students on the domain referenced tests are shown in Table 26. For school 433 the scores of the target students are generally higher and less dispersed than the scores for the total group. Thus the target students are not entirely representative of the group and, as for grade 2, the

Table 26

Comparison of Total Group and Target Students on Means for Three Basic Objectives from Domain Referenced Tests for Three Test Times by School (Grade 5)

Basic objective		School 433 Test time 1 (January)	School 433 Test time 2 (March)	School 433 Test time 3 (May)	School 440 Test time 1 (January)	School 440 Test time 2 (March)	School 440 Test time 3 (May)
Finds product 0-9,999							
Total group	Mean	8.22	7.28	8.49	7.83	6.55	8.15
	(SD)	(2.17)	(2.48)	(1.90)	(3.02)	(2.56)	(2.40)
Target students	Mean	9.33	9.33	9.17	8.67	8.50	8.33
	(SD)	(.82)	(.52)	(1.17)	(1.86)	(1.64)	(1.97)
Finds equivalent common fractions and mixed numbers							
Total group	Mean	3.85	7.79	8.71	5.67	5.43	6.62
	(SD)	(2.56)	(2.77)	(2.14)	(4.17)	(3.36)	(3.25)
Target students	Mean	3.17	9.33	9.17	5.50	4.33	5.83
	(SD)	(2.56)	(.82)	(1.17)	(3.15)	(4.97)	(3.31)
Divides by 1-digit number							
Total group	Mean	6.68	7.90	7.02	4.91	5.79	6.60
	(SD)	(3.51)	(2.14)	(3.34)	(3.83)	(2.29)	(3.12)
Target students	Mean	8.50	7.50	8.17	3.50	4.50	5.50
	(SD)	(1.05)	(2.17)	(2.14)	(3.89)	(2.51)	(3.73)

information collected on engagement may be conservative to the extent that higher ability students tend to be on task more frequently. At school 440, the target students scored slightly higher than the group on finding products, but had lower means than the group for each of the test times on the other two objectives. The relatively large standard deviations for the target group indicate that the target students represented a range in abilities. The grade 5 target students at school 440, then, appear to be a representative sample of students with a range of abilities, more representative of their group than target students from the other groups.

Comparison Between Schools

There were distinct differences between the two schools that reflect differences in when instructional time was spent on objectives. At school 433 students initially began with some competency in multiplication and division, made large increases in achievement on fractions-concepts and computations in period A, and made a large increase in achievement on decimals-computations in period B. The relatively low scores on most objectives for test time 1 provide evidence that the students were grouped closely in their achievement. In contrast, the initial scores on objectives for school 440 were moderately high, .50 or above, suggesting that a number of students had relatively high scores. The large standard deviations on the domain referenced tests lend support to the idea that the students varied significantly in achievement. Thus there was a larger differentiation among students at school 440 than at school 433 which suggests that a larger emphasis was placed on individualization at school 440. Some of the dispersion among scores, however, was

due to the students being in two classes, having two different teachers. Achievement scores at school 440 increased in computes (x/÷) over period A, and in fractions-concepts and fractions-computations in period B. School 433 was slightly ahead of school 440 in the sequence of content from the curriculum. The moderate increases in achievement over the periods provide additional evidence that perhaps not all of the students were given instructions on the same objectives at the same time at school 440.

The domain referenced tests provide similar information in that students at school 433 made the largest increases in achievement in finding equivalent fractions and students at school 440 made the largest increases in achievement on division. At the end of the period of investigation students in both schools had similar achievement on multiplication and division. Students from school 433 at test time 3 were higher in achievement on finding equivalent fractions than students from school 440. Also, students at school 440 had more difficulty finding equivalent fractions involving mixed numbers, which may be a reflection of the difference in the content presented.

Thus, there appear to be differences between the two schools in the instructional approaches taken and the pattern of achievement over time. However, at the end of the total period the achievement level of students on four of the general objectives was very similar--fractions-computations, decimals-concepts, computes (x/÷), and problem solving. Achievement at school 433 was much higher on decimals-computation which is a more advanced topic usually taught in grade 6. Achievement at school 433 was somewhat higher on the remaining objective, fractions-concepts. Similarities are evident between the two schools, which could be the result of both schools

using DMP. There is evidence of a common sequence in achievement on computes (x/÷), fractions, and decimals, and a similar level of achievement is obtained. The changes in achievement on computes (x/÷), fractions, and decimals over the two periods indicate that these topics were taught in the same sequence, although not at the same time, at both schools with similar results.

VII

INTERRELATIONSHIPS AMONG VARIABLES

One main purpose of this descriptive study was to provide information on how DMP was being used in two IGE schools. In the previous chapters the use of DMP has been described with regards to means of instruction, the allocation and use of instructional time, and achievement. In this chapter an indepth analysis is made, describing the relationship of the three sets of variables for each grade at each of the two schools. Such an analysis provides greater insight into the specific use of DMP at each school and helps to identify the emphasis placed on the differentiation of individual students within the groups investigated.

The simplest model of the relationship between instructional time and achievement is a linear one with gain in achievement directly proportional to the amount of instructional time. Such a model provides only an estimate of how the two variables are related, because of many other factors that may have an effect on the relationship. Factors such as content easiness, preachievement, intent of instruction, lesson type, and classroom management all may affect how instructional time is related to achievement. The simple linear model, however, provides a point of reference for a discussion of instructional time and achievement. Deviations from this ideal model suggest critical points of interest in the instructional program. Thus the ideal model will be used in this chapter to help identify critical points with the full realization that the model is simplistic.

In discussing the relationships among variables, scores from the achievement monitoring tests for the three test times will be used. Four measures of instructional time will be used, arranged in a hierarchical fashion: logged allocated time, observed available time, percent of engagement, and the estimate of the total engaged time (derived from a combination of log and observation data). The instructional time is reported in average minutes per student. The instructional time information and achievement are reported separately for grades 2 and 5 along with simple gain scores and graphs of the achievement scores. Objective easiness, which is used to report achievement, is given as the percent correct with possible values ranging from 0 to 100.

Grade 2

School 433. The information on achievement and instructional time for grade 2 at school 433 is shown in Table 27. In general, the information shows that at least some time was spent on each general objective tested during one of the two periods. The largest proportion of the instructional time was spent on three objectives--computes (+/-), counting, and writes sentences (+/-). Regarding achievement, increases were made over both periods on five of the seven objectives tested. On two of the objectives, 04 and 08, a decrease in achievement occurred over one of the periods. In each case, the decrease was associated with no instructional time being allocated to the objective.

The Pearson product-moment correlation between achievement gain and the allocated minutes, when all cases over each period are included, is -0.17. When three outlying cases are excluded, the correlation is

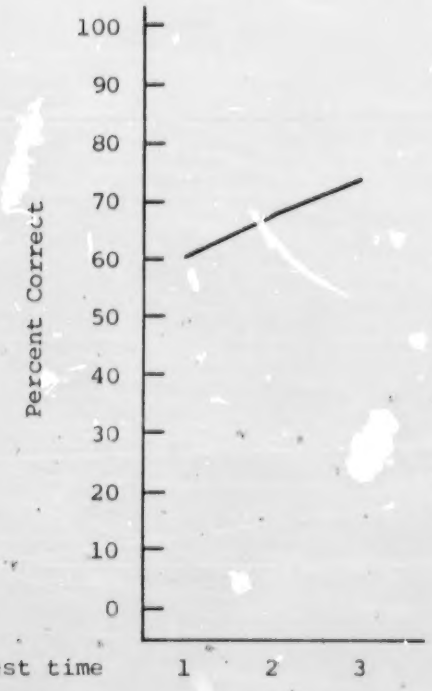
Table 27

Achievement and Instructional Time for School 433, Grade 2

OBJECTIVE # 01

OBJECTIVE NAME

Writes sentence (+/-)



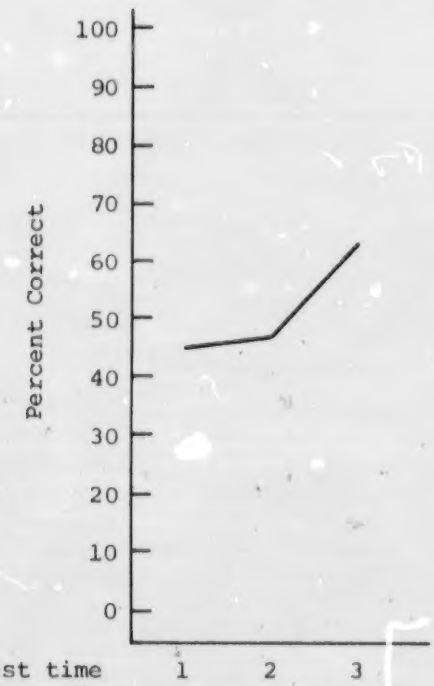
Achievement			
Obj. Ease	61	69	75
Gain		7	6
		13	

Time		
Allocated	77	266 min.
Available	-	29 min.
Engaged	-	86%
Est. Eng.	-	195 min.

OBJECTIVE # 02

OBJECTIVE NAME

Computes (+/-)



Achievement			
Obj. Ease	45	47	64
Gain		02	17
		19	

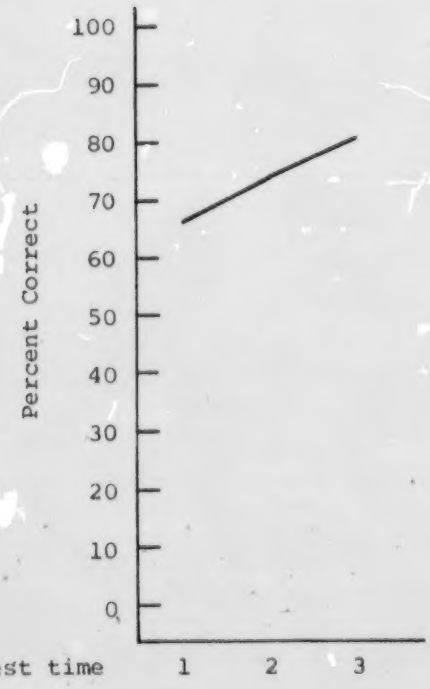
Time		
Allocated	658	241
Available	105	41
Engaged	61%	51%
Est. Eng.	321	98

Table 27 (continued)

OBJECTIVE # 03

OBJECTIVE NAME

Counting



Achievement

Obj. Ease	68	74	81
Gain	06	07	
	13		

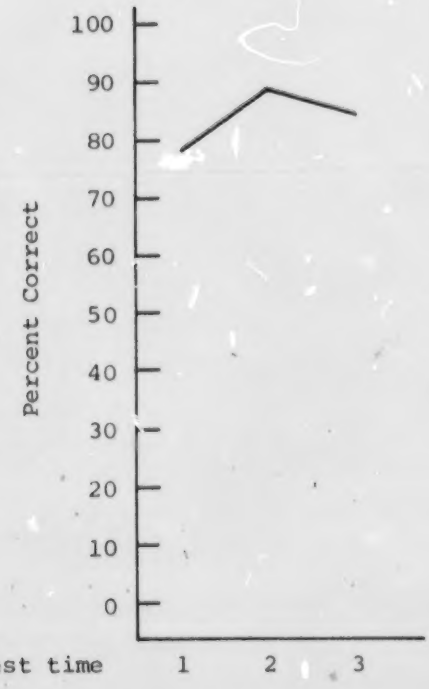
Time

Allocated	236	187
Available	60	68
Engaged	60%	79%
Est. Eng.	118	118

OBJEC IVE # 04

OBJECTIVE NAME

Inequalities



Achievement

Obj. Ease	80	90	87
Gain	10	-3	
	7		

Time

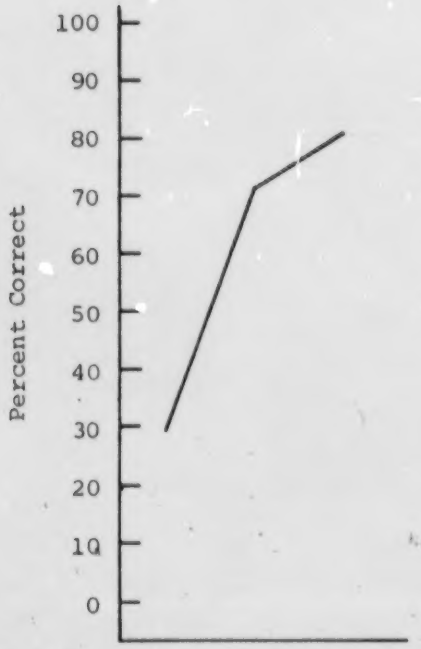
Allocated	132	0
Available	20	-
Engaged	82%	-
Est. Eng.	87	0

Table 27 (continued)

OBJECTIVE # 05

OBJECTIVE NAME

Fractions



Achievement

Obj. Ease	32	72	82
Gain	40	10	
		50	

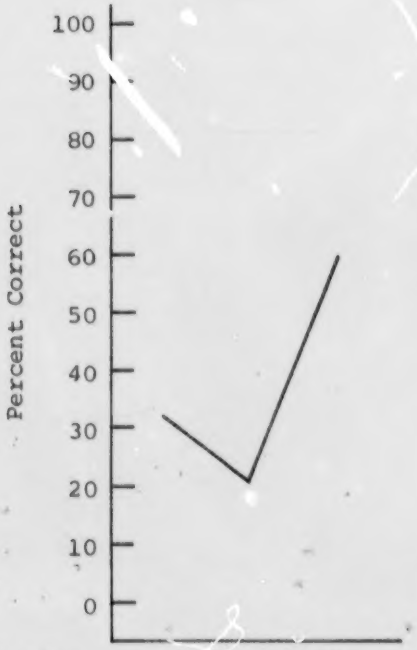
Time

Allocated	25	189
Available	-	-
Engaged	-	-
Est. Eng.	-	-

OBJECTIVE # 08

OBJECTIVE NAME

Measurement/Attributes



Achievement

Obj. Ease	33	24	61
Gain	-09	37	
		28	

Time

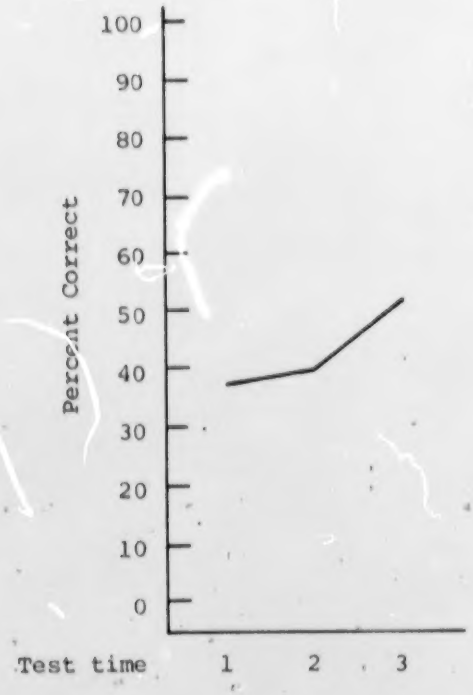
Allocated	0	31
Available	-	-
Engaged	-	-
Est. Eng.	0	-

Table 27 (continued)

OBJECTIVE # 10

OBJECTIVE NAME

Problem Solving



Achievement			
Obj. Ease	38	41	51
Gain		03	09
		12	
Time			
Allocated		11	0
Available		-	-
Engaged		-	-
Est. Eng.		-	0

increased to .59. The three cases are discrepancies to the simple linear model in that a little increase in achievement was associated with a large amount of allocated time or a large gain with a little amount of allocated time. On computes (+/-) a large amount of time, 658 minutes, was spent in period A with an increase in achievement of only two percentage points. On fractions, period A, and measurement/attributes, period B, large gains in achievement occurred, although less than a class period was spent on instruction per student. Overall, there is a poor fit between the data from grade 2 at school 433 with the basic model because of three cases which will be discussed in more detail below. The reasons for the misfit on these three cases will be used to gain insight into the instructional program at the school.

To understand the discrepancy between the large amount of allocated time on general objective computes (+/-) (02) over period A and the low gain in achievement, we need to know more precisely what content was covered and how this compared to what was tested. Most of the instructional time allocated to the objective over period A was spent using Topic 35, Number Sentences (0-20), which involves finding the missing number in an open sentence using numbers 0-20. During period B instructional time related to the objective was spent using non-DMP materials practicing adding and subtracting. The majority of the 20 items (12) over the 4 test forms that were used to test Objective 02 involved open sentences. However, 4 of these items used numbers from 0 to 99. The other 8 items tested vertical addition and subtraction.

At test time 1 students did well on solving open sentences using numbers 0-20, averaging 75% correct. The students scored less

well on solving open sentences using numbers between 20 to 99 and on vertical addition requiring regrouping. Thus, the large amount of time spent on Topic 35 in period A solving open sentences using numbers 0-20 appears to have been spent on material that many of the students had already mastered. The result was a little gain in achievement over period A. When instructional time was spent on computing in period B, this provided practice using skills that were more difficult for the students. The result was a larger increase in achievement on the general objective over period B. The discrepancy on this objective over period A appears to be the result of spending instructional time on material that the students already knew. This indicates that, most likely, no pretesting was done prior to instruction.

On the general objective of fractions (05), the increase in achievement was due to an increase in students' ability to recognize that fractional parts of an area must be of the same size and to determine the fractional parts of a region or set of discrete objects. The small amount of instructional time related to fractions during period A was spent on Topic 32, which involves the grouping of objects. This probably had some effect on the students' abilities to identify partitions of a set as fractional parts, but does not explain all of the large increase on the general objective of fractions. Possibly the scores for test time 1 on the objective were deflated because of the students' unfamiliarity with the item format. Other than this, it is difficult to specify the reason for such a large increase on achievement for such a small amount of instructional time.

Similarly, for general objective measurement attributes, it is difficult to explain the large increase from the information that is available. Because the achievement on the objective was only measured by four items, the achievement scores are less stable than for the other objectives tested. The main increase on achievement was in the ability of students to measure length in centimeters. No coding category was available for metrics, so increases may reflect some instructional time that was allocated but not recorded. However, with the data available, the reasons for the inconsistency between the small amount of instructional time reported and the large gain in achievement are unclear.

Thus, with the exception of three cases, amount of instructional time allocated is related to gain in achievement for grade 2 at school 433. It is difficult to explain two of the discrepant cases where a small amount of instructional time was associated with large gains in achievement. For the third case, the instructional time appears to have been spent on content that most students had already mastered or nearly mastered which resulted in a very small gain in achievement.

School 440. The information on achievement and instructional time for grade 2 at school 440 is shown in Table 28. Instructional time was allocated to five of the seven general objectives that were tested. No time was allocated to fractions or problem solving over the 14 weeks of investigation. The three general objectives with the most allocated time were computes (+/-), counting, and measurement/attributes. The achievement on four of the objectives--01, 02, 03, and 08--generally increased over both periods. Achievement in the other three objectives all decreased over one of the time periods. No instructional time was

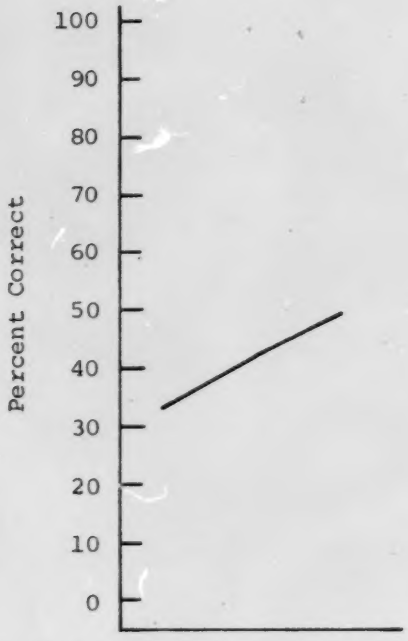
Table 28

Achievement and Instructional Time for School 440, Grade 2

OBJECTIVE # 01

OBJECTIVE NAME

Writes sentence (+/-)



Test time 1 2 3

Achievement

Obj. Ease	33	41	48
Gain		8	7
		50	

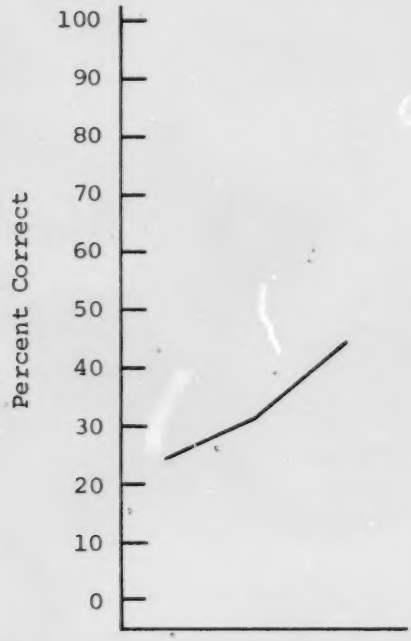
Time

Allocated	147	97 min.
Available	17	-
Engaged	54%	-
Est. Eng.	66	-

OBJECTIVE # 02

OBJECTIVE NAME

Computes (+/-)



Test time 1 2 3

Achievement

Obj. Ease	24	31	44
Gain		7	13
		20	

Time

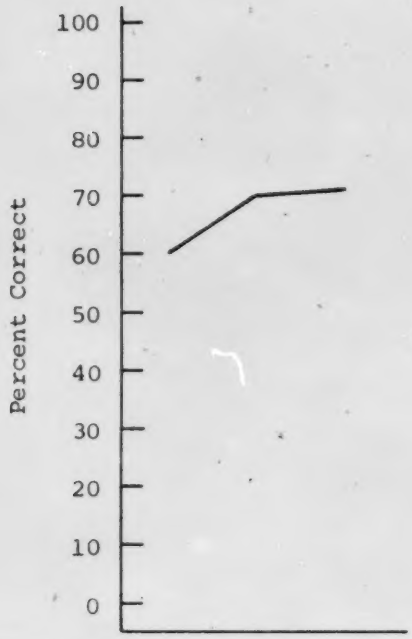
Allocated	314	521 min.
Available	66	116
Engaged	53%	67%
Est. Eng.	138	260

Table 28 (continued)

OBJECTIVE # 03

OBJECTIVE NAME

Counting

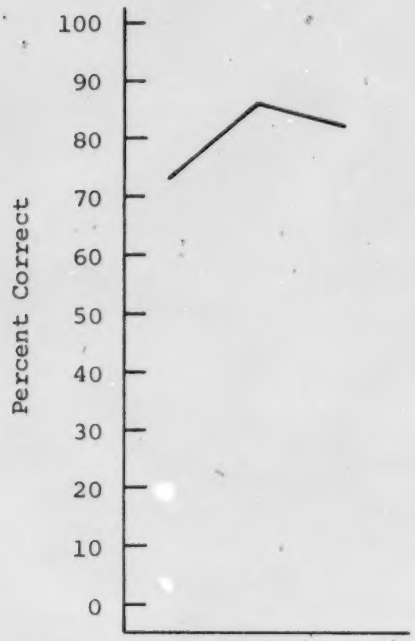


Test time	1	2	3
Achievement			
Obj. Ease	60	69	70
Gain		9	1
		10	
Time			
Allocated	413	81	
Available	106	3	
Engaged	60%	68%	
Est. Eng.	204	41	

OBJECTIVE # 04

OBJECTIVE NAME

Inequalities



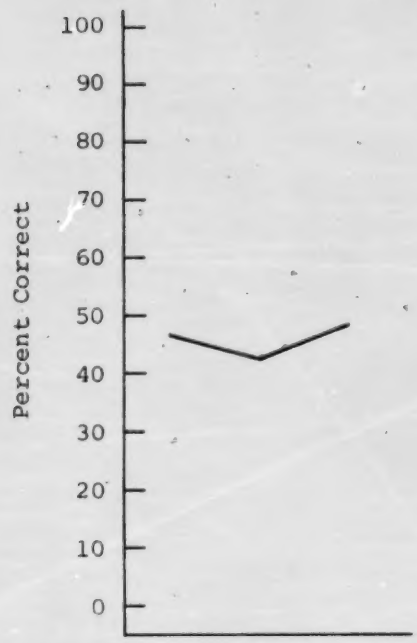
Test time	1	2	3
Achievement			
Obj. Ease	73	86	82
Gain		13	-4
		9	
Time			
Allocated	70	27	
Available	24	9	
Engaged	74%	48%	
Est. Eng.	42	10	

Table 28 (continued)

OBJECTIVE # 05

OBJECTIVE NAME

Fractions



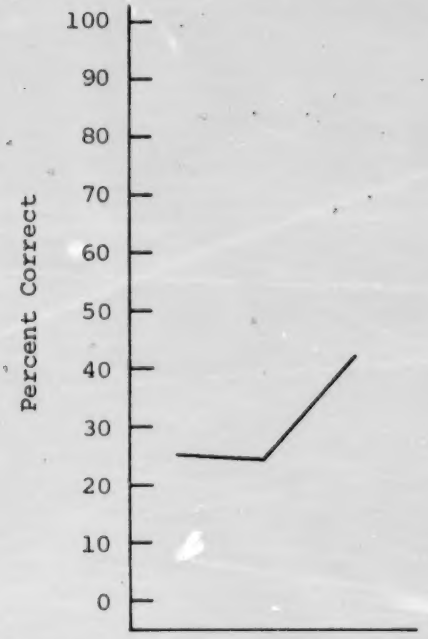
Achievement			
Obj. Ease	46	42	48
Gain		-4	6
		2	

Time		
Allocated	0	0
Available	-	-
Engaged	-	-
Est. Eng.	0	0

OBJECTIVE # 08

OBJECTIVE NAME

Measurement/Attributes



Achievement			
Obj. Ease	25	24	42
Gain		-1	18
		17	

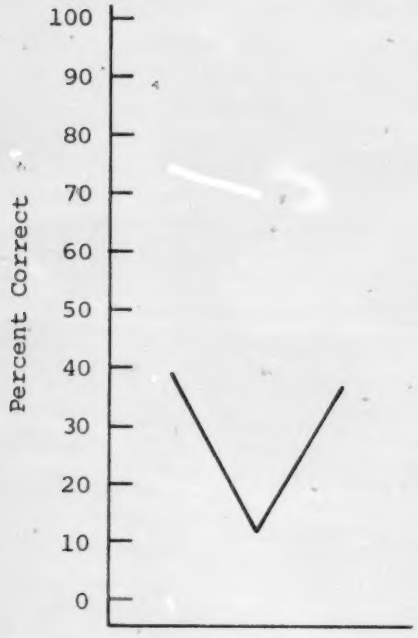
Time		
Allocated	183	251
Available	10	70
Engaged	55	56
Est. Eng.	83	104

Table 28 (continued)

OBJECTIVE # 10

OBJECTIVE NAME

Problem Solving



Test time	1	2	3
Achievement			
Obj. Ease	39	11	36
Gain		-28	25
			-3
Time			
Allocated		0	0
Available		-	-
Engaged		-	-
Est. Eng.		0	0

allocated to two of these objectives. The third objective, inequalities, had only a small amount of allocated time.

The Pearson product-moment correlation between achievement gain and the allocated minutes for all cases over each period is .34. This indicates a small positive relationship between the two variables. On the four objectives which were allocated the largest amount of time, the largest gains in achievement occurred over the period with the greater amount of allocated time. On the two objectives, fractions (05) and problem solving (10), for which no time was allocated, increases in period B were preceded by decreases in period A. The changes in achievement on fractions over the three test times were most likely due to normal variations in the testing caused by the imperfections of the instruments rather than to changes in the ability of the students. Similarly, the low score for test time 2 on problem solving appears to be an anomaly. The change over the total period for both of these objectives is small, which would be expected considering no instructional time was spent on either objective. The fluctuation between the two periods appears to be related to random error in the tests.

There were three cases where some instructional time was allocated over the period but there was no increase in achievement. On counting (03) over period B, 81 minutes per student was allocated with a gain of only one percentage point. All of this time was spent by only one of the two classes. Thus, achievement by students in one class could have been dampened by some decline in achievement by students in the other class. Similarly, for inequalities (04) over period B, the time on this objective was all spent by students from one class. In contrast, over period A,

where there was an increase in achievement, time was allocated to inequalities in both classes. These cases where there was a decrease in achievement, or only a slight gain, appear to reflect the fact that different students received different instruction. Increases in achievement by some students were probably counteracted by decreases in achievement by other students, particularly if no maintenance activities were employed for students who had already received instruction.

The slight decline in achievement over period A on measurement/attributes (08) can be interpreted as no change at all in achievement. The four test items representing this objective only test the ability of students to measure the length of an object. The time allocated to instruction on this general objective was all spent using Topic 34, Units of Capacity, which is not related to measuring length. Thus, the lack of gain in achievement is understandable. In period B, the time allocated to this objective was also spent on capacity and attributes, which does not explain the gain in achievement of 18 percentage points. Thus, as for school 433, the gain in achievement is probably associated with factors not apparent from the data.

For grade 2 at school 440 there is a positive relationship between instructional time and achievement. The cases where time was allocated and little gain or even a decline in achievement occurred were associated with either only one class spending time on the objective or with instructional time not being related to the test items used to measure the objective. The objectives on which no time was allocated had very little gain over the total period and showed sporadic shifts in achievement over the two periods. The fact that two classes of students were involved in

the study appeared to have affected the way instructional time was related to achievement.

Comparison of the two schools. The achievement curves for both schools on the four general objectives 01, 02, 03, and 04 are very similar in shape. In all cases the initial achievement was higher for school 433; however, the increases in achievement by both schools were essentially parallel on each of these objectives. The instructional time allocated to these objectives varied by school. Certain topics were not used at school 433. The topics presented at school 433 were Topics 32, 33, 35, 37, and 38, whereas the topics used at school 440 were 32, 33, 34, 35, and 36. These differences account for much of the variation in the allocation of instructional time. On the first four general objectives, similarities between the two schools in the shape of the achievement curves and the range of allocated time can be associated with both schools using DMP.

Differences between the two schools are more apparent on the other three objectives. The increase in achievement on fractions at school 433 can be explained by students having some work in Topic 37, Partitioning, which is a more advanced topic not reached by school 440. As can be expected, school 440 showed little gain on fractions. Increase on the general objective problem solving at school 433 indicates another difference between the two schools. Even though little or no time was allocated to problem solving at either school, students at school 433 increased in achievement on this objective and students at school 440 did not. Students at school 433 may have improved their computational skills sufficiently during period B to affect their ability to solve

problems. Because of the small number of items used to assess achievement on measurement/attributes, it is difficult to explain the difference between the two schools regarding this objective.

The means of instruction used varied only slightly between the two schools at grade 2. More self-paced individual and small group activities were used at school 440 than at school 433. The use of materials and the patterns of interactions, primarily teacher-to-group, were similar. Thus, the differences in achievement between the two schools appear to be related to the differences in content covered rather than to differences in the means of instruction.

Contrasting the two schools on the individualization of instruction is difficult since only the middle range group of students participated from school 433 whereas all of the students from school 440 participated. There is evidence that on one objective, computes (+/-), instructional time was spent on content on which students at school 433 already had some degree of competency. Also large increases in achievement over one period indicated that most of the students in the group had covered the same content. However, at school 440, where the two classes had instruction on an objective at different times, the overall gain in achievement for the group was reduced. Thus, there were few differences in the individualization of students between schools that could account for the differences in achievement.

Grade 5

School 433. All of the math instructional time during the period of investigation for grade 5 at school 433 (Table 29) was allocated either

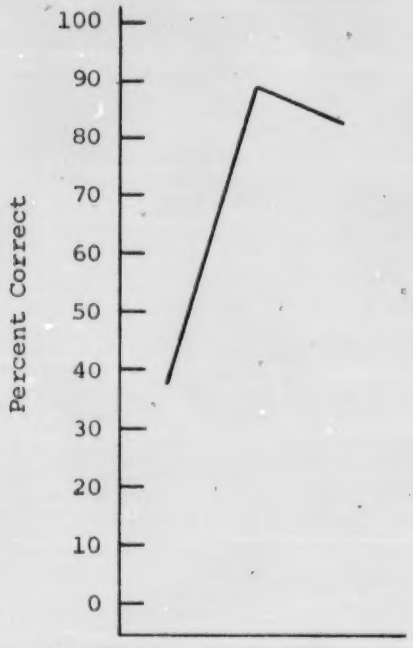
Table 29

Achievement and Instructional Time for School 433, Grade 5

OBJECTIVE # 03

OBJECTIVE NAME

Fractions-Concept



Achievement

Obj. Ease	37	89	82
Gain	52	-7	
	45		

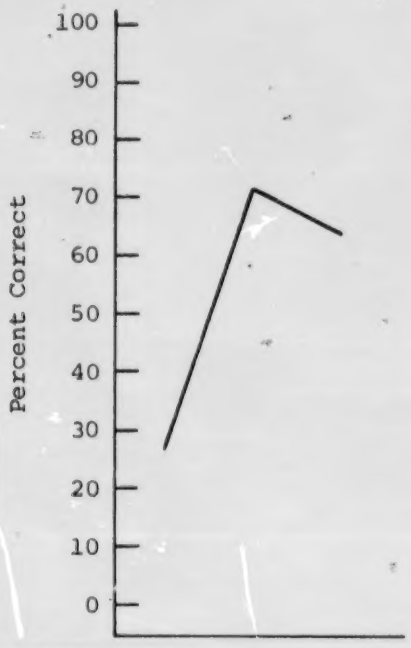
Time

Allocated	900	430
Available	119	39
Engaged	68%	80%
Est. Eng.	462	282

OBJECTIVE # 04

OBJECTIVE NAME

Fractions-Computation



Achievement

Obj. Ease	28	71	63
Gain	43	-8	
	35		

Time

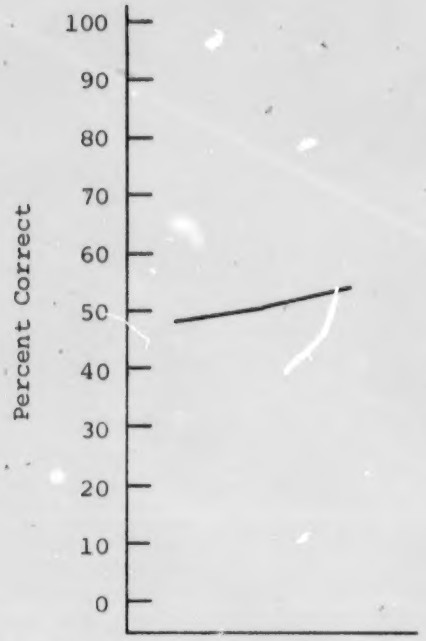
Allocated	600	200
Available	97	114
Engaged	75%	74%
Est. Eng.	337	121

Table 29 (continued)

OBJECTIVE # 05

OBJECTIVE NAME

Decimals-Concepts



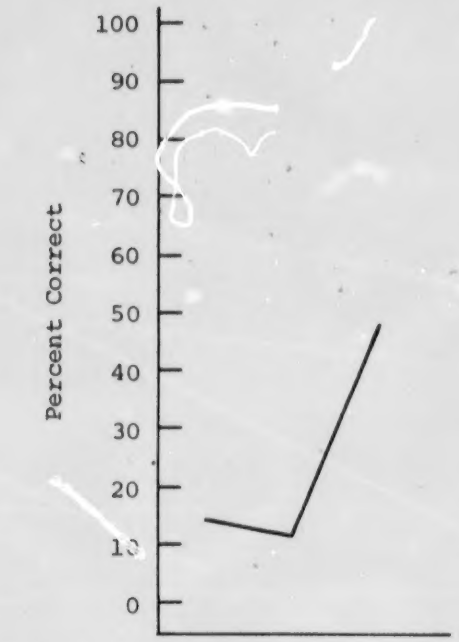
Achievement			
Obj. Ease	48	51	56
Gain		3	5
		8	

Time		
Allocated	25	50
Available	-	-
Engaged	-	-
Est. Eng.	-	-

OBJECTIVE # 06

OBJECTIVE NAME

Decimals-Computation



Achievement			
Obj. Ease	1[illegible]	12	49
Gain		-4	37

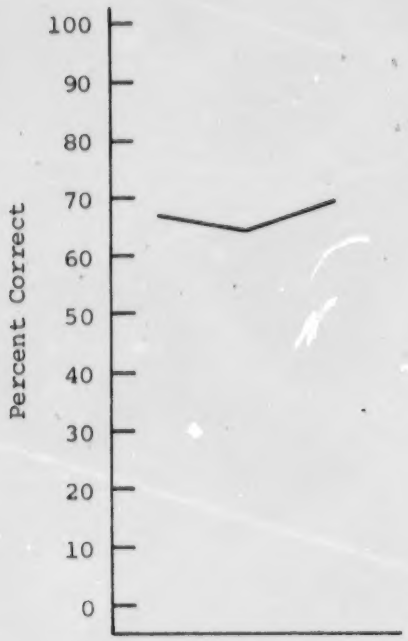
Time		
Allocated	0	570
Available	-	97
Engaged	-	70%
Est. Eng.	0	329

Table 29 (continued)

OBJECTIVE # 07

OBJECTIVE NAME

Computes (X/÷)

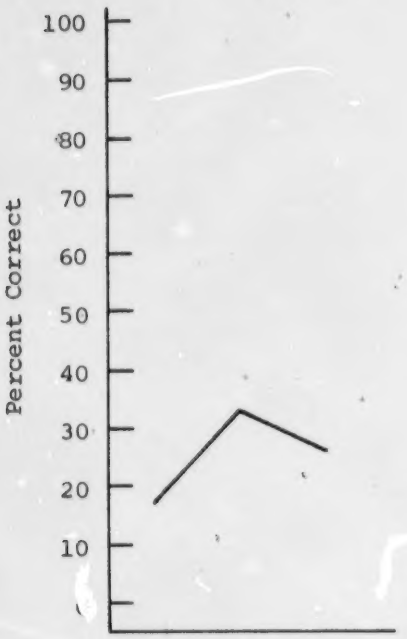


Test time	1	2	3
Achievement			
Obj. Ease	67	64	69
Gain		-3	5
		2	
Time			
Allocated	0	0	
Available	-	-	
Engaged	-	-	
Est. Eng.	0	0	

OBJECTIVE # 10

OBJECTIVE NAME

Problem Solving



Test time	1	2	3
Achievement			
Obj. Ease	17	33	27
Gain		16	-6
		10	
Time			
Allocated	0	0	
Available	-	-	
Engaged	-	-	
Est. Eng.	0	0	

to fractions or decimals. There was no differentiation in instruction among the students who participated; each student was allocated the same amount of time on each objective covered. Fractions-concept was allocated the most time followed by fractions-computation. The time allocated to decimals was primarily in period B.

Only for the general objective decimals-concepts did achievement increase over both periods. On all of the other objectives there was a decrease in achievement over one of the periods. The Pearson product-moment correlation of .80 between achievement and instructional time is high and is mainly due to the number of extreme points, which represent either a large amount of time allocated and a large increase in achievement or no allocated time and a relatively small change in achievement.

Three cases occurred that did not fit the simple linear model of the relationship between instructional time and achievement. Two of these occurred during period B after large increases in achievement occurred over period A. Each student was allocated in period B 430 minutes on fractions-concepts and 200 minutes on fractions-computation. However, on both of these objectives there was a decrease in achievement over period B. The decrease on fractions-concepts appears to be over all of the basic objectives forming the general objective and not just on one specific subdimension. Over 50% of the materials used in instruction on fractions-concepts over period B were non-DMP materials which indicates that much of the time was spent in practice activities. The only reasonable explanation for the decline in the scores on fractions-concept over period B, other than expected variation in scores due to random error in the instruments, is that fractions were taught at the beginning of the

period. During the last 3 weeks of the period, instructional time was allocated only to decimals. This gave students 3 weeks to forget some of the content they had learned regarding common fractions and mixed numbers. Thus it appears the decrease in achievement is due to not maintaining the obtained level of achievement through maintenance activities. This reason also appears applicable to the decline in scores on fractions-computation over period B. On this general objective the students had more difficulty with computations using mixed numbers.

The third discrepant case occurred for the general objective of problem solving over period A where there was a significant increase in achievement without any instructional time being allocated. Some of the problems used as items measuring achievement on this objective included computations using fractions. Part of the increase on problem solving is probably related to the students' increase in competency with computations using fractions. Other increases in scores occurred on problems requiring multiplication and division. The decrease in achievement over period B also appears to be associated with the slight decline in computing with fractions. Thus changes over the total period on problem solving appear to be more related to variations in computing skills rather than problem solving skills.

The achievement curves for grade 5 for school 433 reflect the mode of instruction used, which was mainly large group instruction with the teacher talking for nearly 50% of this time. All of the students were given the same instruction, arranged in blocks of days. First instructional time was spent on fractions and then on decimals. As a result, a large increase in achievement on fractions occurred over period A. A large increase in achievement on decimals, with some decline in scores on

fractions, occurred over period B. There appears to have been no maintenance for the fraction objectives during the instructional time spent on decimals.

School 440. Grade 5 at school 440 (Table 30) provides an interesting contrast to grade 5 at school 433. On many objectives, only one of the two classes at school 440 was given any instruction on the objective. Only for fractions-concept over period B and computes (x/÷) over period A did both classes receive instruction on the objective during the same period. Some instructional time over the period of investigation was spent, at least by some of the students, on each of the six general objectives tested. Thus, even though the amount of time reported in Table 30 is an average across all students, in reality time was spent only by a half or less of the group of students that were tested.

The Pearson product-moment correlation between instructional time and achievement for grade 5 at school 440 is .77. None of the cases appear to be large deviations from the simple linear model. On the objective decimals-concepts (05), decreases occurred over both periods even though some time was allocated to this objective during period A. This time, however, was only spent by approximately one-third of the group which apparently was not enough to yield an overall increase in achievement. On computes (x/÷), the instructional time reported for period B was only spent by students in one of the two classes. The decline in achievement of two percentage points should be interpreted as no change in achievement which can be expected considering the very little time spent on the objective during period B.

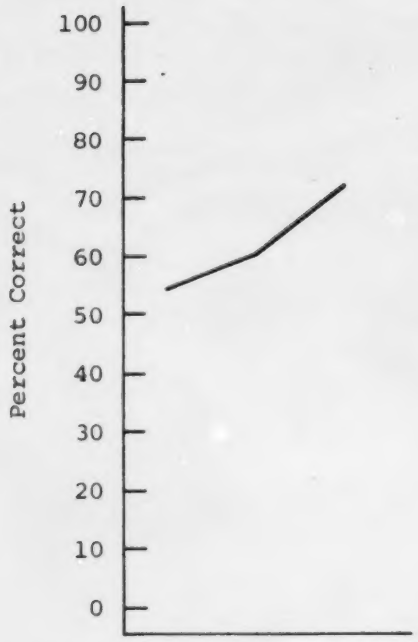
Table 30

Achievement and Instructional Time for School 440, Grade 5

OBJECTIVE # 03

OBJECTIVE NAME

Fractions-Concepts



Test time 1 2 3

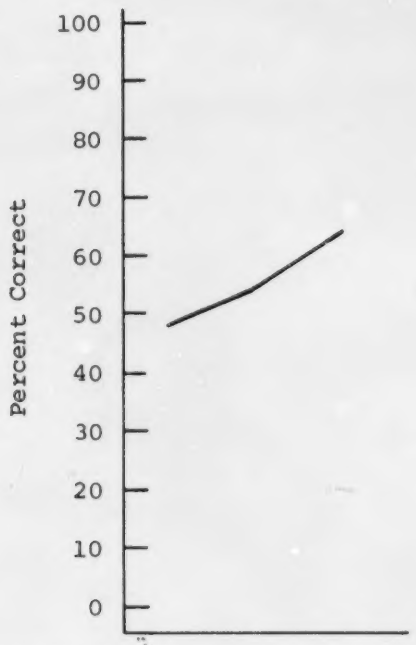
Achievement			
Obj. Ease	54	60	72
Gain		6	12
		18	

Time		
Allocated	58	726
Available	4	86
Engaged	55%	69%
Est. Eng.	29	422

OBJECTIVE # 04

OBJECTIVE NAME

Fractions-Computation



Test time 1 2 3

Achievement			
Obj. Ease	48	54	64
Gain		6	10
		16	

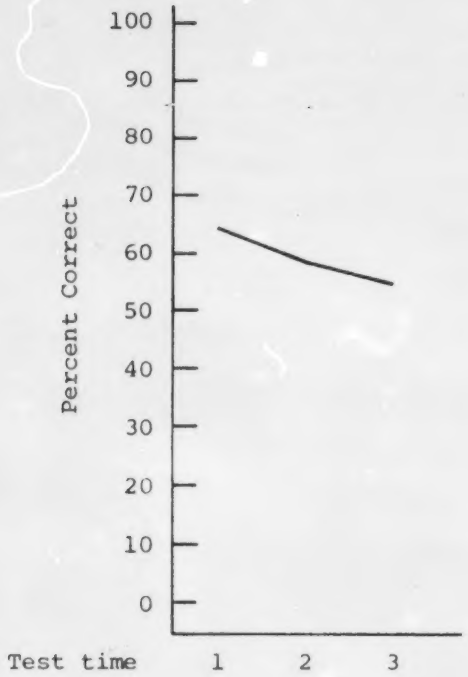
Time		
Allocated	26	201
Available	-	146
Engaged	-	59%
Est. Eng.	-	101

Table 30 (continued)

OBJECTIVE # 05

OBJECTIVE NAME

Decimals-Concepts



Achievement

Obj. Ease	63	58	54
Gain		-5	-4
		-9	

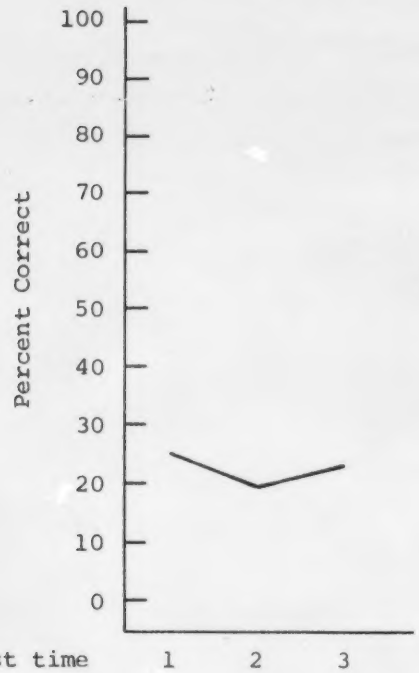
Time

Allocated	24	0
Available	2	-
Engaged	96%	-
Est. Eng.	20	0

OBJECTIVE # 06

OBJECTIVE NAME

Decimals-Computation



Achievement

Obj. Ease	25	20	24
Gain		-5	4
		-1	

Time

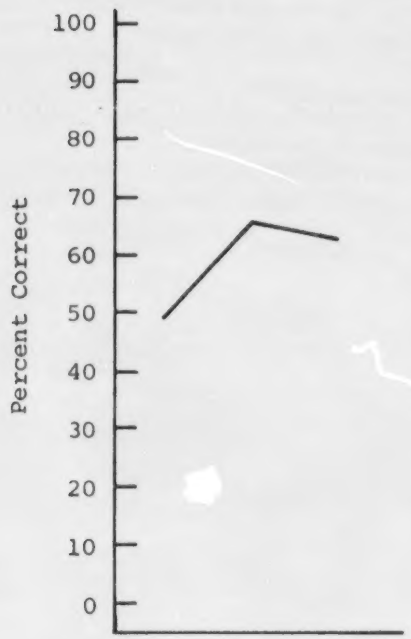
Allocated	0	87
Available	-	12
Engaged	-	79%
Est. Eng.	0	58

Table 30 (continued)

OBJECTIVE # 07

OBJECTIVE NAME

Computes (X/÷)



Achievement

Obj. Ease	49	64	62
Gain		15	-2
		13	

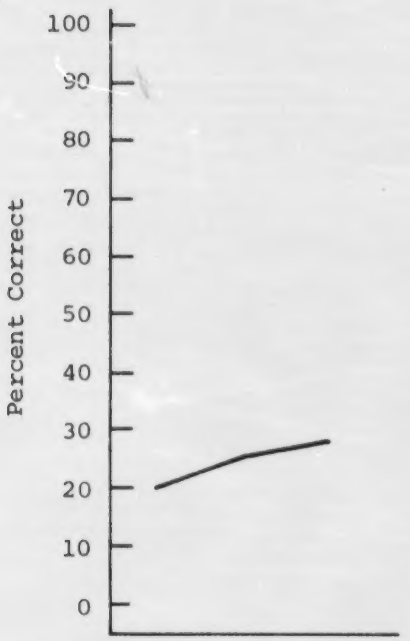
Time

Allocated	1,020	29
Available	261	42
Engaged	69%	84%
Est. Eng.	628	20

OBJECTIVE # 10

OBJECTIVE NAME

Problem Solving



Achievement

Obj. Ease	20	25	28
Gain		5	3
		8	

Time

Allocated	148	0
Available	24	-
Engaged	44%	-
Est. Eng.	59	0

Thus there is a very strong relationship between instructional time and achievement for grade 5 at school 440. The moderate increases in achievement over the two periods reflect the differentiation in content covered by the two classes and by individual students within the classes. Where no instructional time was allocated or only a little time was spent by a fraction of the students, declines in achievement occurred, for example on decimals-concepts. On some of the objectives levels of achievement were not maintained over the period of investigation. The two teachers differed in their approaches to instruction in that one generally blocked instruction by spending instructional time mainly on multiplication and division during period A and on fractions during period B. The other teacher had students working on a range of objectives over both periods. This is reflected in the achievement curves with the largest gains in achievement occurring when the greatest number of students were given instruction on an objective--computes (x/÷) over period A and fractions-concepts over period B.

Comparison of the two schools. The grade 5 teachers at the two schools were very different in their instructional approaches, and this is reflected in the achievement scores. Large jumps were made on three of the objectives by students at school 433, whereas steady increases were made on three of the objectives at school 440. The final levels of achievement are similar for both schools on fractions-computation, decimals-concepts, computes (x/÷), and problem solving despite the differences at the beginning of the investigation and the varying instructional approaches.

The similarities between the two schools in student outcomes appear to be, at least in part, associated with both schools using DMP. Some of the same topics were used at both schools. The differences in student outcomes between the two schools appear related to how the materials were used and the sequence in which topics were given. Selected topics were used at school 433 allowing more advanced topics, e.g., Topic 84, to be presented. At school 440 a larger number and a wider range of topics were used. However, students did not advance as far on particular topics such as decimals. In the sequence of topics, no student at school 440 advanced beyond Topic 81. This difference in the topics covered resulted in the largest difference in achievement between the two schools, which occurred on decimals-computations at test time 3. Otherwise, the results at both the schools were similar.

Essentially no individualization of students occurred at school 433. The group proceeded through instruction as a unit. At school 440 some differentiation among students was made. However, this was mainly done by using worksheets from sources other than DMP. DMP provided some flexibility in the selection of topics for instruction so that a range of content areas could be presented or instruction could be strictly sequenced.

References

Harnischfeger, A., & Wiley, D. E. Teaching-learning processes in elementary schools: A synoptic view (Studies in Educative Processes, Report No. 9). Chicago: University of Chicago, 1975.

Harris, C. W., & Pearlman, A. P. An index for a domain of completion or short answer items. Journal of Educational Statistics, 1978, 3, 285-303.

Klausmeier, H., Rossmiller, R., & Saily, M. (Eds.). Individually guided education: Concepts and practices. New York: Academic Press, 1977.

Marliave, R., Fisher, C., Filby, N., & Dishaw, M. The development of instrumentation for a field study of teaching (Beginning Teacher Evaluation Study, Technical Report I-5). San Francisco: Far West Laboratory for Educational Research and Development, 1977.

McDonald, F. J., & Elias, P. A report on the results of phase II of the beginning teacher evaluation study. Journal of Teacher Education, 1976, 17, 315-332.

Nerenz, A. G. WDRSD and DMP teacher interview for the descriptive study of phase IV of the IGE evaluation project (Project Paper 79-30). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980.

Nerenz, A. G., & Webb, N. L. Aggregation and scaling of variables for the descriptive study of phase IV IGE evaluation project (Project Paper 80-1). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980.

Otto, W. The Wisconsin Design: A reading program. In H. J. Klausmeier, R. A. Rossmiller, & M. Saily (Eds.), Individually guided education: Concepts and practices. New York: Academic Press, 1977.

Romberg, T. A. IGE evaluation: Perspectives and a plan (Working Paper No. 183). Madison: Wisconsin Research and Development Center for Cognitive Learning, 1976.

Romberg, T. A. DMP: The elementary mathematics program for Individually Guided Education. In H. J. Klausmeier, R. A. Rossmiller, & M. Saily (Eds.), Individually guided elementary education: Concepts and practices. New York: Academic Press, 1977.

Romberg, T. A., Harvey, J. G., Moser, J. M., & Montgomery, M. E. Developing mathematical processes. Chicago: Rand McNally, 1974, 1975, 1976.

Rosenshine, B. V. New insights and questions from recent research in elementary schools. Paper presented at the meeting of the American Educational Research Association, New York, April 1977.

Webb, N. L. Grade 5 observation data for two DMP schools: Descriptive study (Project Paper 79-18). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (a)

Webb, N. L. Log data for two DMP schools: Grade 2 and 5 descriptive study of phase IV of the IGE evaluation project (Project Paper 79-20). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (b)

Webb, N. L. Math achievement measures developed for the descriptive study of phase IV of the IGE evaluation project (Project Paper

79-28). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (c)

Webb, N. L. Math domain referenced tests descriptive study test time I (Project Paper 79-9). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (d)

Webb, N. L. Math domain referenced tests descriptive study test time II (Project Paper 79-11). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (e)

Webb, N. L. Math domain referenced tests descriptive study test time III (Project Paper 79-13). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980. (f)

Webb, N. L. Math achievement monitoring test descriptive study test time I (Project Paper 79-1). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (g)

Webb, N. L. Math achievement monitoring test descriptive study test time II (Project Paper 79-4). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (h)

Webb, N. L. Math achievement monitoring test descriptive study test time III (Project Paper 79-7). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (i)

Webb, N. L. Observation data for grade 2 students at the two DMP schools: Descriptive study (Project Paper 79-15). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (j)

Webb, N. L. Observation procedures for the descriptive study of the IGE evaluation project (Project Paper 79-32). Madison:

Wisconsin Research and Development Center for Individualized Schooling, 1979. (k)

Webb, N. L. Teacher logs for the descriptive study of phase IV of the IGE evaluation project (Project Paper 79-31). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979. (l)

Webb, N. L., & Romberg, T. A. The design for the study of reading skills and mathematics curriculum products IGE evaluation project--phase IV (Project Paper 79-42). Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979.

Center Planning and Policy Committee

Marshall S. Smith
Director

Dale D. Johnson
Area Chairperson
Studies in Language:
Reading and Communication

Marvin J. Fruth
Area Chairperson
Studies in Implementation
of Individualized Schooling

Penelope L. Peterson
Area Chairperson
Studies of Instructional Programming
for the Individual Student

James M. Lipham
Area Chairperson
Studies of Administration and
Organization for Instruction

Thomas A. Romberg
Area Chairperson
Studies in Mathematics and Evaluation
of Practices in Individualized Schooling

Associated Faculty

Vernon L. Allen
Professor
Psychology

B. Dean Bowles
Professor
Educational Administration

Thomas P. Carpenter
Professor
Curriculum and Instruction

W. Patrick Dickson
Assistant Professor
Child and Family Studies

Lloyd E. Frohreich
Professor
Educational Administration

Marvin J. Fruth
Professor
Educational Administration

Dale D. Johnson
Professor
Curriculum and Instruction

Herbert J. Klausmeier
V.A.C. Henmon Professor
Educational Psychology

Joel R. Levin
Professor
Educational Psychology

James M. Lipham
Professor
Educational Administration

Dominic W. Massaro
Professor
Psychology

Donald M. McIsaac
Professor
Educational Administration

Wayne Otto
Professor
Curriculum and Instruction

Penelope L. Peterson
Associate Professor
Educational Psychology

Thomas S. Popkewitz
Professor
Curriculum and Instruction

Gary G. Price
Assistant Professor
Curriculum and Instruction

W. Charles Read
Professor
English and Li[illegible]stics

Thomas A. Romberg
Professor
Curriculum and Instruction

Richard A. Rossmiller
Professor
Educational Administration

Peter A. Schreiber
Associate Professor
English and Linguistics

B. Robert Tabachnick
Professor
Curriculum and Instruction

Gary G. Wehlage
Professor
Curriculum and Instruction

Louise Cherry Wilkinson
Associate Professor
Educational Psychology

Steven R. Yussen
Professor
Educational Psychology